

Psychological Bulletin

THE GLOMUS BODY AS A RECEPTOR OF CUTANEOUS PRESSURE AND VIBRATION

BY B. VON HALLER GILMER

Carnegie Institute of Technology

I. INTRODUCTION

In the enormous amount of literature on the sensitivity of the body to vibratory stimulation no consideration, other than speculative, has been given to the possible receptors of vibration. In fact, even the nature of the processes underlying the perception of vibration has long been the subject of controversial interpretation. Some writers have maintained that vibratory sensibility is mediated by the bones and periosteum, some have postulated a special "vibratory sense," and other writers have considered the perception of vibration to be a function of the tactual end-organs responsible for "contact" and "pressure." A review of the literature on the perception of mechanical vibration and an account of the theoretical interpretations of vibratory sensibility have been given in a recent series of papers by Geldard (10, 11, 12, 13). A review of the literature on the perception of vibration induced by electrical currents can be found in a 1937 publication by Von Skramlik (26).

An examination of the experimental findings on general vibratory sensibility leads the writer to believe that there may exist different kinds of mechanisms for mediating vibratory perceptions. The recent investigations of Geldard (11), Gilmer (15), Piéron (24), and Weitz (30) have concurred with the early views of Von Frey (9) and others that cutaneous vibratory sensibility is but another temporal expression of pressure. The work of Echlin and Fessard (8) on the response of "stretch receptors" in frogs, cats, and rabbits, however, would seem to leave open the possibility of kinaesthetic mediation of vibration in man. Perhaps other mechanisms may be involved in the general perception of vibration, but in the present investigation our consideration has been an attempt to determine the receptor or receptors of *cutaneous* vibration as another temporal expression of pressure sensitivity.

Aside from such inadequately supported guesses as that Meissner corpuscles and the corpuscles of Pacini may function in the reception of pressure and vibration, little consideration has been given to possible pressure-vibration receptors. The attempts that have been made to establish correlations between the various cutaneous sensory qualities of pressure, pain, and temperature and their possible receptors have, on the whole, been inconclusive.

The attempts that have been made to find the relationship between possible sense receptors in the skin and the several cutaneous sensory qualities have involved two different kinds of excision studies—"direct" and "indirect." The term "direct" excision may be used to describe the removal and the histological analysis of cutaneous tissue directly underlying a specific skin area or sensory "spot." "Indirect" excisions may be described as those including an histological analysis of comparatively large skin areas taken from surgical specimens without predetermining precise sensory "spots," or the analysis of rather large skin areas containing a number of known sensory "spots" but without attempting to specifically correlate a given sensory "spot" with the tissue directly underlying it. For purposes of this paper only the results of the "direct" excision investigations are reviewed.

In 1885 Donaldson (7) performed the first "direct" excision experiment when he made an histological examination of the tissue underlying cold spots and warm spots. Since no specialized end-organs were found beneath the sensory spots, the results of this investigation were interpreted as being "negative." One year later Goldscheider (17) examined histologically tissue containing warm, cold, and pressure-sensitive spots removed from the forearm. He reported finding no corpuscular nerve endings but different forms of arborized nerve tissue. Goldscheider found it difficult anatomically to distinguish between the nerve terminations corresponding to the warm and cold spots, but regarded the plexus as underlying a temperature sense and having a specific relation to blood vessels. Haggqvist (21), in 1913, reported finding smooth muscle bundles under cold spots.

In 1923 Stetson (27) reported a series of experiments dealing with the relationship existing between the hair follicle and the sense of pressure. These investigations were made with the hairs on the scrotum. Stetson concluded that pressure sensation in this hairy region is mediated by the upper part of the follicle and possibly by the skin surface at the point of emergence. He also maintained that inducing a deformation of the skin surface near the point at which the hair emerges can excite these endings. Strughold and Karbe (28), in 1925, working on the conjunctiva of the eye, suggested a relationship between the cold spots and Krause end-bulbs. But whether one can apply this correlation in dealing with the external skin is in question.

In 1927 Dallenbach (4) found in serial sections taken from excisions of cold and warm spots only free nerve endings. He concluded that these, besides functioning in pain, also subserve the functions that Von Frey reservedly ascribed to Krause end-bulbs and Ruffini cylinders. One year later Pendleton (23) reported that no specific end-organ was found in biopsies containing cold sensitive tissue.

Waterston (29), in 1933, explored the terminal part of the fingers for touch, pain, and temperature sensation. The epidermis was then removed by slicing. He reported that no pain, but only touch, was sensed by this removal. Histological examination of the removed portions of the epidermis were made. Fine nerve fibers were found, terminating in the epidermis in "loops and figures." Waterston concluded that this demonstration of the presence of nerve fibers and their terminals in the tissue which had been removed, without causing any pain, completes the evidence necessary to establish the theory that the nerves of the epithelium are the nerves of light tactile sensation and that they do not under ordinary conditions convey impulses which give rise to pain. Waterston does not consider pressure to be a cutaneous sensation. He maintains that pressure is elicited on the surface of the skin if stimulation is sufficiently strong to affect deeper tissues such as the muscle or the periosteum. The possible organs of temperature sensation were not revealed by these excision experiments.

Conducting excision studies on the mammary gland, Belonoschkin (1), in 1933, attributed to a nonencapsulated ending, situated 0.1 to 2 millimeters below the epidermis, the mediation of cold sensation. These endings were apparently similar to those reported by Woppard (32) in 1935. Working with sections of skin on the volar surface of the forearm, Woppard found immediately in the vicinity of the cold spots a complicated nerve plexus lying subjacent to the epithelium and just above the loops of the capillaries. This plexus consisted of fibers of moderate thickness which branched and subdivided in a diffuse manner. The terminations were of the form of expansions of considerable size, sometimes elongated and sometimes ovoid. The ends were nonencapsulated, although they were close enough together to give the impression of a well-localized ending.

II. PRESSURE-VIBRATION SPOTS AND THEIR UNDERLYING TISSUES¹

Although both "direct" and "indirect" excision studies have not convincingly shown any specific relationships between the various cutaneous sensations and their possible receptors, we became interested in making another attempt along this line. Many writers have regarded most, if not all, of the excision investigations

¹ The material in this section of the paper is the joint work of Dr. S. R. Haythorn and the writer. For a detailed description of the methods of surgical extirpation, the histological techniques employed, and for a full description of the tissues found in each biopsy, the reader is referred to our original publication (16).

as giving "negative" results. But a careful perusal of some of the extirpation studies will show that the findings were "negative" only in the sense that specific receptors were looked for and not found.

Recent advancements in the methods of locating sensory areas on the surface of the skin and improved histological techniques further added to our interest in the problem of attempting to identify the receptors of cutaneous pressure and vibration.

Localization and Excision of the Sensory Areas

The methods employed in localizing the pressure-vibration sensitive spots have been described in detail in an earlier publication by Gilmer (15).

Two methods of locating these spots were used.² One involved the application of amplified alternating electrical currents, generated from a beat-frequency oscillator, to the surface of the skin by a small needle electrode. The apparatus was provided with a voltmeter and milliammeter for measuring sensory thresholds in terms of power. Using this method, one can localize pressure-vibration sensitive spots with accuracy, since these electrical stimulations elicit various patterns either of pain associated with feelings of vibration or of vibration free of pain experiences. Vibration sensations are here defined as those giving only clear perceptions of interrupted pressure, the vibratory "pattern" entirely free from all pain experiences. Thus, through applying the alternating electrical currents to the surface of the skin by the needle electrode, one can easily "tune in" the pressure-vibration spots. Exploring the skin for pressure-vibration spots in this manner offers certain advantages over trying to localize pressure spots by means of hairs or other conventional esthesiometers.

The second method of localizing the pressure-vibration sensitive spots made use of a mechanically vibrated needle powered by the amplified current from a beat-frequency oscillator. After the general area of vibratory sensitivity had been determined by using the alternating electrical currents, the point or points of maximum sensitivity to mechanical vibration were determined. Thresholds were measured in terms of amplitude swing of the needle. The actual frequency of the vibrating needle while in contact with the skin and the extent of the mechanical transmission of vibratory "waves" through the tissues was determined stroboscopically. In exploring the skin for the vibration-sensitive spots, a frequency of 100 cycles was arbitrarily used. However, before excisions were made, the frequency range for each sensitive area was determined.

After the vibration-sensitive spots had been determined by the above methods, each spot was tested for pressure sensitivity by the use of a hair

² Appreciation is expressed here to Mr. Irwin Rosenberg, who aided in this part of the experiment.

esthesiaimeter. In general this latter procedure confirmed the localizations obtained by the electrical and mechanical vibration stimulations.

Each pressure-vibration sensitive spot was marked by the Dallenbach injection technique (6), and the sensitivity of each was checked periodically for several weeks. The spots were found to remain stable in their position, and they yielded virtually the same vibratory thresholds from day to day. Before the excisions were made, each spot was tested for temperature sensitivity.

Nine "direct" excisions were made in our investigation, the biopsies being removed from two subjects who were well trained in the observation of cutaneous sensitivity. Of these nine biopsies, taken from regions of the back and arms, three contained only pressure-vibration sensitivity; two were highly sensitive to cold stimulation in addition to having pressure-vibration sensitivity; and two contained tissues sensitive to warmth along with sensitivity to pressure and vibration. The two remaining biopsies were taken as "controls." We were unable to find skin areas large enough for adequate excision that were completely free from sensitivity to pressure, vibration, and temperature. Therefore, our "control" biopsies contained tissues which were relatively insensitive to mechanical vibration, pressure, and temperature stimulation, and which transmitted primarily feelings of pain in response to the electrical stimulation.

The excisions, some two to three millimeters in diameter, were made with a scalpel.³ In each biopsy the pressure-vibration sensory "stimulus point" was localized near the center of the surface area. The skin tissue was removed in a conical shape, the biopsies ranging in depth from about two to six millimeters. The deeper excisions went well below the dermic level into the subcutaneous fatty tissue. The more shallow excisions went only through the dermic layer of the skin. Each biopsy was removed under local novocain anaesthesia, the anaesthetization having no effect upon the histological techniques used. Immediately upon the removal, the excised tissue was placed in a fixing solution.

In order that each biopsy should be investigated thoroughly, a routine search of each section was made layer by layer for the following structures:

The Malpighian layer was studied for free filaments of nonmedullated nerve fibers, for filaments ending in the tactile discs of Merkel-Ranvier, and for the argentophile Langerhans cells.

The corium was searched for arborized terminal branches of networks of nonmedullated fibers, especially for those immediately beneath the Malpighian layer, for end-brushes of Ruffini, for angular swellings of the filaments, for endings in and on the vascular walls, for independent glomeruli in the connective tissues, and for the encapsulated end-organs including Meissner's corpuscles, Ruffini's cylinders, Krause's end-bulbs, and the end-bulbs of Pacini.

Perivascular arborizations were traced from section to section. Their networks and disc-like endings were sought in and about arterioles, capillaries, and venules.

³ Dr. Joseph Soffel, of the West Penn Hospital, Pittsburgh, made the surgical excisions.

All sections were examined for arterioles of the glomeric type and for portions of Sucquet-Hoyer canals, which often lead upward from the more deeply-seated glomus bodies of Masson.

Hair follicles, sebaceous glands, sweat glands, and arrectors pili muscles were carefully examined with reference to their nerve supplies. Myelinated nerve bundles were followed for divisions and their relation to other structures.

Individual Biopsies

The nine biopsies described below contain, in order, three which had only pressure-vibration sensitivity, two which were cold sensitive in addition to pressure-vibration sensitivity, two which were sensitive to warmth in addition to their pressure-vibration sensitivity, and two "controls" which were relatively insensitive to pressure, vibration, and temperature stimulation.

Pressure-Vibration Biopsy (s-39-266A). This biopsy was removed from near the middle of the back. The stratum Malpighii showed a considerable number of argentophile cells. Free, nonmedullated plexus were found just beneath the Malpighian layer, and these appeared to be continuous with those about the capillary walls. Perivasculär plexus were abundantly arranged about arterioles, capillaries, and venules and appeared to be the chief channels for the passage of the nerve fibers through the corium to the Malpighian layer. Among the vessels was an arteriole having several layers of cubical, smooth-muscle cells and no internal elastic membrane. It was believed to be an arm-like extension from a glomus body. The biopsy contained one hair follicle with sebaceous glands, two arrectors pili muscles, and one sweat duct. A medullated nerve was seen to divide and connect with a plexus about an arteriole. Serial sections failed to show Meissner's corpuscles, Krause's end-bulbs, Ruffini's cylinders, or Pacinian corpuscles.

Pressure-Vibration Biopsy (s-39-266). This biopsy was removed from the left side of the back near the belt line. The Malpighian layer contained many argentophile, crescent-shaped, Merkel-Ranvier cells. Non-medullated fibers were not seen in the Malpighian layer, although the usual network of sub-Malpighian, arborized fibers was present about the capillaries. One of the vascular plexus contained a structure resembling the cross-section of an arteriovenous anastomosis, but no true glomus body was found. The biopsy contained three widely separated sweat-gland ducts and two bundles of arrectors pili muscles. No encapsulated sensory end-organs of any kind were found.

Pressure-Vibration Biopsy (s-39-387). This biopsy was removed from the left side of the back about 10 inches above the belt line. Some non-medullated nerve fibers extended for a very short distance into the Malpighian layer. Beneath the Malpighian layer was a small group of vessels having a very rich nerve supply. Free filaments were spread out beneath the epithelium. At the side of one of the coils of vessels both medullated and nonmedullated nerves could be seen. In the lower part of several

serial sections there was a portion of a true glomus. It appeared to be connected directly by vascular extensions to the subepithelial capillary plexus, and the perivascular nerves and the arborized subepithelial nerves were intimately associated. At the side of the glomus there was a small bundle of myelinated nerves. The piece contained one hair follicle, three sweat-gland ducts, and several small groups of arrectors pili muscles. No encapsulated end-organs were found.

Pressure-Vibration—Cold Biopsy (s-39-267). This biopsy was removed from the ventral surface of the left forearm midway between the wrist and the elbow. The Malpighian area was covered with a thick cornified layer and contained the mouths of several sweat ducts. Nonmedullated fibers were found entering the Malpighian layer. Crescent-shaped nuclei with vacuoles around them were accepted as Merkel's corpuscles. Silver-positive subcutaneous brushes of radiating fibers were found extending upward through the papillae into the Malpighian coat. One of the brushes occurred just at the end of a capillary at the tip of a papilla. Similar fibers followed the course of the capillary into the corium. Perivascular arborizations were present. There were several small loops having cubical or square muscle-cell coats suggestive of a loop of a Sucquet-Hoyer canal, save that they were not more than two layers thick. The biopsy contained two hair follicles, a sebaceous gland, two arrectors pili muscle bundles, and several sweat-gland ducts. There was a coil of sweat glands at the bottom of the section with a fairly large medullated nerve trunk and two loops of the muscular coils of a glomus body beside it. No encapsulated end-organs were found.

Pressure-Vibration—Cold Biopsy (s-39-814). This biopsy was removed from the ventral side of the arm near the wrist. The Malpighian layer showed the usual number of Merkel's cells. This section presented the most highly vascular, subepithelial zone of any biopsy studied. The vessels were unusually numerous, unusually superficial, and tended to run parallel to the Malpighian layer at right angles rather than perpendicularly. Many of the capillary walls were surrounded by a very loose network of reticulum and argentophile fibrils resembling nerve endings. At the tip of the section there was a group of vessels having slightly thicker walls than those just beneath the epithelium in which cubical-muscle cells and numerous nerve ends were found. It was either a part of a glomus body or one of the cubical-muscle extensions connected with a glomus body. At the base of the piece there was a bundle of medullated nerves. The glomus-like body had a myelinated nerve bundle at the side of it, and one small nerve could be seen to break up into a subepithelial plexus. A sweat-gland duct and two arrectors pili muscles were located near the center of the block. Encapsulated nerve end-organs and hair follicles were absent.

Pressure-Vibration—Warmth Biopsy (s-39-1897). This biopsy was removed from the dorsal side of the arm near the wrist. In the Malpighian layer there were cells of the Merkel-Ranvier type. No connection between these cells and nerve fibers could be traced with certainty. In the region of the papillae there were sprays of argentophile fibrils continuous with the reticulum and nonmedullated plexus of the corium. These

sprays were far more numerous in the regions of the papillae where they appeared to enter the Malpighian layer and radiate among the epithelial cells. The basement membrane was interrupted at the papillae. In the subcutaneous areas there were anastomoses of argentophile fibrils that surrounded the vessels. In some of the first of the serial sections there were several large hair follicles with coils of sweat glands, small nerve trunks with papillary muscles near them. At the lower border of the corium there were two vascular canals with smooth-muscle coats at right angles to their lumina. In the later sections of the series these two structures joined. Near the vessel there was a small bundle of medullated nerves. The vascular structure resembled a loop of a Sucquet-Hoyer canal. There were three vascular structures in this biopsy which resembled loops of Sucquet-Hoyer. The perivascular plexus were unusually abundant throughout the biopsy. No encapsulated end-organs were found.

Pressure-Vibration—Warmth Biopsy (s-9A and B). This biopsy was removed from near the middle of the back and was the only one which showed any of the original patterns of sensitivity after excision. Therefore, the tissue underlying this sensory spot was removed a second time, seven months after the first removal. The first excision went a depth of less than two millimeters. The second excision included the scar tissue which was formed by the first operation and went an additional depth of five millimeters. At the time of the first excision (A) the tissue was sensitive to pressure, vibration, and warmth. At the time of the second excision (B) pressure had diminished. Stimulation of the scar tissue by intense mechanical vibration gave the experience of the tissue "vibrating as a mass." No sensitivity could be elicited by the alternating electrical currents, since we were unable to establish electrical contact through the scar tissue. Two months after the first excision the spot was again highly sensitive to warmth stimulation.

(A) The block was small and cut parallel to the surface. Merkel-Ranvier cells were present. A few argentophile (Langerhans) cells stood out clearly. They appeared to be fixed epithelial cells in the basal layers. The vessels were of the ordinary arteriole-capillary types with the usual perivascular nerve reticula. The subepithelial reticulum was not stained. The section contained three hair follicles and sweat-gland ducts. No encapsulated end-organs were found. The piece was too superficial to be of much value.

(B) The Malpighian layer had completely regenerated, although the papillary layer was flattened for a short distance toward one side of the section, and the Malpighian layer over this area was not cornified. In this area the collagen was abundant, compressed, and with Masson's stain gave a staining reaction of scar tissue. There were three sets of hair follicles in the corium, one of which had a double shaft. Two sweat-gland ducts passed entirely through the corium and ended in sets of sweat-gland coils in the stratum subcutaneum. There were two somewhat tortuous arterioles having circularly arranged muscle coats. They were situated in the deeper layers of the reticular stratum, and one of them was accompanied by a medullated nerve trunk. No partial or complete glomus bod-

ies were present. The two vessels with circularly arranged muscle walls could have been related to glomus bodies, but they were not sufficiently typical to be identified as portions of Sucquet-Hoyer canals. The superficial vessels were of the usual arteriolar-capillary-venous type. No encapsulated end-organs were found.

"Control" Biopsy (s-39-386). This biopsy was relatively insensitive to pressure, vibration, and temperature stimulation. It was removed from near the middle of the back. The Malpighian layer contained many fibers that took up the silver stain. One fiber could be traced to a Merkel cell. There was a large arteriole of the ordinary type in the corium with many branches spreading out beneath the Malpighian coat and extending into the papillae. The argentophile reticulum about the vessels was heavily stained, and the nerve fibers could not be differentiated from the reticular fibrils in the silver preparations. There was a sweat-gland duct leading down through the center of the biopsy. No glomus bodies were found, and there were no encapsulated sensory end-organs.

"Control" Biopsy (s-39-815). This biopsy was relatively insensitive to pressure, vibration, and temperature stimulation. A good pressure-vibration spot was located near, but not included in, the biopsy. This biopsy was removed from the small of the back. Cells resembling Merkel's cells were present, although no nerve ends or fibers to Merkel's cells could be found. There was a rich argentophile reticulum just beneath the epithelium. The section was relatively nonvascular in so far as the subepithelial supply was concerned. The perivascular arborizations were loose and less noticeable than in the other biopsies. In one of the marginal sections there appeared to be a loop of vessel showing a thick, cubical-cell muscular coat of the type often associated with the Sucquet-Hoyer canals. It disappeared early and was not found in any of the remaining slides. There were several hair follicles, sweat glands, groups of arrectors pili muscles, and coils of small myelinated nerve trunks in the section. One Meissner corpuscle was found in this biopsy.

General Analysis of the Biopsies

In making an interpretation of the above findings, three things are in evidence:

(1) These excision studies failed to substantiate the conventional claim that the cutaneous pressure qualities are mediated by specific sense receptors.

(2) The possibility that the neurovascular system of the skin operates either in a direct or indirect manner in the mediation of cutaneous pressure and vibration is suggested by two findings: (a) The neurovascular system of the skin contains certain structural units richly endowed with a nerve supply surrounded by regions of less nerve concentration. (b) Biopsies taken from the skin areas highly sensitive to pressure and vibratory stimulation were found to contain a richer afferent-arterial nerve supply than

those biopsies taken as controls in which the tissue was less sensitive to pressure and vibration.

(3) The presence in several of the biopsies of spots sensitive to pressure and vibration of certain tubular, straight canals having muscular walls which appeared to unite the glomeric bodies of the stratum subcutaneum with the capillary zone of the stratum papillare and the presence of this rich reticular nerve supply served to strengthen our postulation that the arteriovenous anastomoses, or glomus bodies, in the skin are in some way related to sensory interpretations.

Masson (22), in 1924, surmised that the glomus bodies may serve to mediate pressure sensitivity, since they are most numerous in skin regions in which there is a good sense of touch, and in the extreme parts of the digits they are most abundant and developed. Other than this observation by Masson no investigators have considered the possible sensory functions of the glomus body, as far as the writer has been able to determine, save for certain general postulations as to the sensory functions of the general neurovascular system. Since no descriptions of the glomus bodies have been found in the psychological literature, the writer feels that it is in order to give a brief historical account and description of these mechanisms before turning to further points of consideration.

III. THE GLOMIC UNIT OF THE NEUROVASCULAR SYSTEM

Much of the historical description of the glomus bodies or permanent arteriovenous anastomoses has been centered around their anatomical structures. Other concern has been given to their motor functions. Many accounts can be found in the literature describing glomus tumors, but relatively little mention has been made of the possible sensory functions of the glomus body. Extensive reviews of the literature dealing with the glomeric units of the neurovascular system have been given by Popoff (25) and by Clark (2). Only a brief account of this historical material will be given here.

It is apparent from a study of the literature that early investigations of the vascular system led to certain theoretical beliefs that the growth of permanent arteriovenous anastomoses was very improbable. Perhaps this position in part accounts for the fact that well-established recognition of these structures has come only within the last two decades.

Clark (2) has pointed out that J. Müller, as early as 1844,

described direct connections between arteries and the cavernous sinuses of the penis. In 1862 Sucquet described direct connections about 0.1 millimeter in diameter between arteries and veins in man in the skin of the elbow, knee, lips, cheeks, nose, temple, eyelids, forehead, ears, fingers, toes, and thenar and hypothenar eminences. Sucquet spoke of these connections as a "circulation dérivative." Other investigators failed to find these connections described by Sucquet and considered them artifacts. However, in 1877 Hoyer reported finding these connections in several types of animals in the ear, nose, toes, and at the base of the nail. He found them in man only in the hand and foot and in the sex organs. Extensive studies of these connections in the ear of the rabbit showed that some were straight and others were coiled. According to Clark, the name "arteriovenous anastomosis" appeared first in the writings of Gerard in 1895.

Grosser, in 1902, gave the classical description of the histology of the arteriovenous anastomoses as found in the fingers and toes of man. In the beds of the nails and balls of the fingers and toes he found anastomoses measuring 10 to 30 micra, inside diameter, and 55 to 150 micra, outside diameter. Grosser was one of the first to emphasize the richness of the nerve supply of the arteriovenous anastomoses.

Many other investigators gave similar descriptions of the arteriovenous anastomoses following these earlier accounts. But it was not until 1924 that Masson brought these structures from a position of little more than academic interest to one of physiological and pathological significance. Masson was the first to describe certain pathological conditions connected with the normally present arteriovenous anastomoses.⁴ His descriptions of the painful tumors associated with these anastomoses have led to a vast amount of investigation of such tumors. Pathological literature contains many descriptions of glomus tumors as found in conditions of inflammation, arteriosclerotic gangrene, diabetic gangrene, and thromboangiitis obliterans. Other typical descriptions of such

⁴ The term "normally present" arteriovenous anastomoses is used in this connection to differentiate them from certain types of anastomoses caused by injuries with the resulting formation of connections between arteries and veins which may or may not become permanent. These latter anastomoses lack, in the main, the important neuromuscular mechanism found in the normally present structures. The references made to arteriovenous anastomoses in this paper refer to those normally present in the tissues of the body.

tumors can be found in the works of Popoff (25) and Grauer and Burt (20).

It was because Masson felt that a confusion might arise between the description of these pathological tumors and other unusual vascular connections which have received the same name that he suggested the use of the term "glomus tumors" instead of tumors of the arteriovenous anastomoses. And it follows that some writers began to speak of the normal arteriovenous anastomosis as the "glomus." In 1935 Masson spoke of "les glomus cutanes de l'homme." Two years later, in view of the richness of the nerve supply of the glomus, he used the term "les glomus neurovasculaires." The term "body" has also been used in connection with the glomus. For purposes of description and with a view to avoiding a possible confusion between arteriovenous anastomoses found normally in the subcutaneous and dermic regions of the skin and the anastomoses found in other bodily tissues, the writer prefers to speak of *cutaneous glomus bodies*.

Although the cutaneous glomus bodies vary as to size, shape, and distribution, each contains certain characteristic anatomical structures which mark them as distinct units of the neurovascular system. One of the most complete descriptions of these structures has been given by Popoff (25).

Popoff has described the digital glomus as a specifically constructed and specifically located system. Histologically, the Sucquet-Hoyer canal is one of the easier parts of the structure to identify, and Popoff describes this canal as a main part of the glomus. Popoff summarizes the essential characteristics of the Sucquet-Hoyer canal and the entire digital glomus as follows:

- (1) The glomic system occupies a definite zone in the cutis.
- (2) One afferent glomic artery forms from one to four separate Sucquet-Hoyer canals.
- (3) The beginning of the Sucquet-Hoyer canal is marked by the presence in the afferent artery of cushion-like endotheliomuscular elevations, the function of which is to direct the blood flow into the Sucquet-Hoyer canals and preglomic arterioles.
- (4) The wall of the Sucquet-Hoyer canal is rather thick and has a specifically arranged structure.
- (5) The Sucquet-Hoyer canal is free from elastic tissue, with the exception of its proximal part.
- (6) The Sucquet-Hoyer canal is surrounded with a clear, wide zone consisting of loose, fine collagenous reticulum enclosing a rich network of nonmedullated nerve fibrils. This clear zone may be considered as an expansion zone which is furnished with a neuroreticular mechanism controlling the function of the Sucquet-Hoyer canal.

(7) The glomeric unit is supplied with a specifically arranged system of preglomeric arterioles, which nourish all the constituents of the glomus and form an integral part of a functional glomeric unit.

(8) Primary collecting veins, though lacking in musculature, are richly supplied with elastic tissue. They collect blood not only from the Sucquet-Hoyer canal but also from the preglomeric arterioles. Being long and wide, they encircle the glomeric unit and thus form a voluminous receptaculum, which has a highly developed surface area.

(9) The entire glomus is surrounded with coarse, lamellated collagenous tissue, which separates the glomus from other structures of the cutis.

Figure 1 shows a schematic drawing of the glomus and some of its constituents.

Studies of the motor functions of the glomus began about 1930

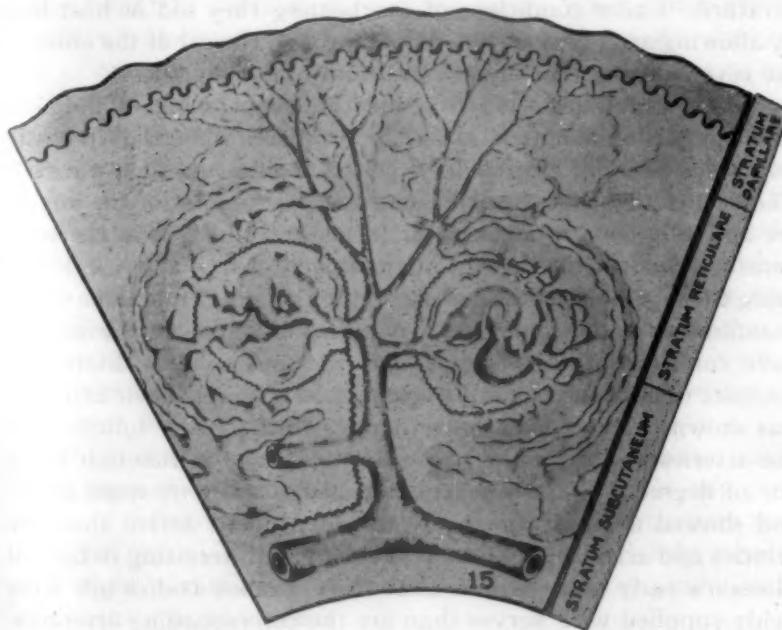


Fig. 1. Diagrammatic presentation of vascular arrangement and the glomus, as found in the ventral surface of the digit. It shows: (1) all the zones of the skin, including that occupied by the glomeric apparatus; (2) the afferent artery of the glomus; (3) the coiled type of Sucquet-Hoyer canal, characterized by a thick wall; (4) the efferent part of the Sucquet-Hoyer canal entering the primary collecting vein, with the latter appearing as a long, wide ruffle encircling the glomus; (5) the relation of the primary collecting vein to other veins; (6) the system of preglomeric arterioles supplying all the constituents of the glomus and emptying into the primary collecting vein; and (7) division of the periarterial nerve trunks, with branches going to the glomus.

(Reproduced, with permission, from N. W. Popoff, *Arch. Path.*, 1934, **18**, 306; 307.)

with the work of Grant (18). Using the intact ears of living albino rabbits, he found it possible to see occasional arteriovenous anastomoses by means of pulsation at their point of entry into the vein when they were dilated. In fixed and stained preparations he demonstrated that such pulsation points were true arteriovenous anastomoses. Grant observed that the anastomoses dilated when the body temperature of the rabbit was raised, and they closed under conditions of cooling. He further showed that local mechanical stimulation, acetyl-cholin, and histamine caused dilatation, while adrenalin and faradic stimulation of the sympathetic produced constriction of the anastomoses. Grant concluded that arteriovenous anastomoses are important in regulating body temperature. Under conditions of overheating they aid in heat loss by allowing an enormous blood flow through the ear of the animal, the reverse being true under conditions of cooling.

Grant and Bland (19) recorded the temperature of the skin of the fingers of man at several different places while the tip of the finger was held in ice water for a period of time and then warmed. They concluded that the arteriovenous anastomoses of the fingers are active in contraction and dilatation and function in the temperature changes of the skin of the finger. Clark and Clark (3), using the ingenious method of observing the motor functions of the anastomoses in the rabbit's ear by means of transparent windows, have confirmed the assertions that the anastomoses dilate and contract under conditions of warming and cooling. Their behavior was shown to have much in common with the motor functions of the arteries and arterioles, the chief difference in function being one of degree. The arteriovenous anastomoses were more active and showed a greater tendency to independent action than the arteries and arterioles. These latter data are interesting in light of Masson's early observations that these glomus bodies are more richly supplied with nerves than are the corresponding arterioles.

That the glomus bodies serve motor functions in regulating body temperature, both local and general, is generally agreed. Precisely how this regulation is effected is at present a matter of speculation.

IV. EVIDENCES THAT THE CUTANEOUS GLOMUS BODIES FUNCTION IN THE MEDIATION OF PRESSURE AND VIBRATION

From the evidence obtained through our "direct" excision experiments and the data gathered "indirectly" through histological

analysis of surgical specimens, the writer postulates that the cutaneous glomus body functions as a receptor of cutaneous pressure and vibration, if not as the receptor of these sensations. This postulation is supported by several secondary sources of evidence.

Glomus Body Distribution

The distribution of the cutaneous glomus bodies throughout the skin shows a marked comparison to the known distribution of pressure-vibration sensitivity of the skin. For example, the palmar surfaces of the hands and the soles of the feet are areas almost uniformly sensitive to pressure and to vibration, and it is known that here the cutaneous glomus bodies are very numerous. On the other hand, the dorsal surface of the fingers is comparatively insensitive to pressure and vibration, and here one finds relatively few glomus bodies. Again, the fingernail is very sensitive to mechanical vibration, and it is known that the nail bed is richly supplied with these structures. Other studies on the distribution of cutaneous glomus bodies apparently warrant the conclusion that the skin regions most generally sensitive to the mediation of the pressure qualities are also those regions richly endowed with glomic units of the neurovascular system. And those skin regions which have comparatively few pressure-vibration spots also have comparatively few glomus bodies. It is also interesting to note that on regions of the skin where the two-point limen of pressure is small, more glomus bodies are found than on those regions where the two-point limen is large.

There is some disagreement among the various investigators as to the actual number of glomus bodies present in any given region of the skin. But suffice it to say that all investigators agree that the regions of the hands and toes are abundantly supplied with these structures. A few figures from these quantitative studies may be of interest.

Grant and Bland (19) give the following distribution of the glomus structures per square centimeter area of the hand: nail bed of index finger, 501; tip of index finger, 236; palmar surface of third phalanx, 150; palmar surface of second phalanx, 20; palmar surface of first phalanx, 93; thenar eminence, 113; and hypothenar eminence, 96. Their figures per square centimeter of the second toe of the foot show: nail bed, 593; pad, 293; sole near heel, 197. Popoff (25) gives lower figures than these. He points out that the quantitative results of such studies are influenced by a number of factors of which age of the individual and the pathological processes are the most important. His examination of the digital vascular system in fetuses from the age of four and one-half months to term dis-

closed complete absence of the Sucquet-Hoyer canal. (Besides using the term digital glomus, Popoff often speaks of the "Sucquet-Hoyer canals" for arteriovenous anastomoses. This term does have some descriptive value in identifying the cutaneous glomus structure.) Popoff estimates the average number of these canals per square centimeter of surface area in the big toe of a normal person 20 years of age to be: ventral surface, 18; lateral surface, 10; nail bed, 24; and nail matrix, 12. The figures he obtained from corresponding parts of the thumb were approximately the same. It will be noticed that these figures are strikingly lower than those of Grant and Bland. The latter investigators obtained their data on cadavers 24 hours after death with the method of intravascular injection of washing, fixing, and using coloring fluids. Popoff used fresh surgical material, fixed *in situ*, which revealed the state of the vascular digital system as it existed at the time of fixation.

In addition to those data which describe the relative distribution of the normal glomus bodies throughout the skin, some mention should be made of the various regions in which glomus tumors have been located. This may be of significance in view of the fact that most of the recent literature on glomus bodies has been concerned with their abnormalities, and glomus tumors have been found in some regions of the body where no one has attempted to find the normal structures.

Many data on the distribution of glomus tumors have been given in the literature of pathology. These tumors have been found chiefly in the extremities and the subungual regions of the fingers and toes. Other cases have, however, been reported from regions of the thigh, calf of the leg, knee, ankle, forearm, elbow, upper arm, and penis.

In 1939 Grauer and Burt (20) pointed out that in 40 to 50% of the tumors recorded there was a previous history of trauma and that the average duration of their presence, from the time of their appearance to the development of symptoms, was nine years. The smaller tumors reported were usually subungual, while the larger ones were found in regions where the tissue was easily distensible.

Age and Vibratory Sensitivity

Our second secondary source of evidence which supports the claim that the cutaneous glomus body functions as a receptor of cutaneous pressure and vibration centers about the well-known fact that vibratory sensitivity decreases with advanced age. As a corollary to this gradual loss of sensitivity with age, studies show that the glomus structures are often found to be absent or atrophied in elderly people. Popoff (25) states, for example, that in

persons over 60 years of age the number of digital Sucquet-Hoyer canals per square centimeter begins to decrease, and this decrease progresses with advance in age.

Vibratory Sensitivity and Peripheral Circulation

The writer has observed that sensitivity of the palmar surface of the fingers to mechanical vibration and to alternating electrical currents varies comparatively little for most normal subjects under controlled conditions of stimulation. That is, both the frequency range and the threshold for any given frequency will not vary greatly among people of appreciably the same age and among those persons with apparently normal blood circulation. However, the author has noticed that in subjects with apparently poor digital circulation the vibratory threshold at any given frequency may be as much as 10 times as high as the threshold for the "average" subject. Similarly, such subjects have a shorter range of frequency sensitivity.

Vibratory Sensitivity and Skin Temperature

Another indirect source of evidence which shows a relationship between vibratory sensitivity and the activities of the neuro-vascular system of the skin is shown by the work of Weitz (31). Working on limited regions of the volar and dorsal surfaces of the arm, he found that increasing the skin temperature surrounding "vibration spots" decreased the vibratory thresholds to a minimum, at which point, with further heating, the thresholds were increased. With decreasing skin temperature vibratory thresholds showed a continuous rise. These data are important from our point of view, since it is known that the glomus bodies dilate with increased temperature, to a point where constriction occurs, and contract when the regions in which they are located are cooled. Just why the vibratory thresholds are affected in the manner which Weitz has shown is a matter for speculation. However, the important thing is that changes in vibratory sensitivity do occur with temperature changes at the local regions of stimulation. It seems reasonable that some such effect should be present, since the glomus bodies function in peripheral temperature regulation.

V. THEORETICAL CONSIDERATIONS

It has been shown that cutaneous glomus bodies are not found as "isolated" structures in the same sense that one may find en-

capsulated end-organs. Many writers have mentioned variations in the size of glomus bodies and have brought out the fact that some are straight, some tortuous, and some coiled in tight, ball-like knots. Our observations agree with these statements. The compactness, the size, and the shapes of these mechanisms vary with location in the body and with the age of the individual. It is generally agreed that these structures are richly endowed with a nerve supply, apparently containing many sensory fibers as well as motor fibers. In essence, the glomus body may be pictured as a highly innervated neuromuscular unit of the vascular system surrounded by regions of less nerve concentration.

On the basis of our studies we believe the glomic unit of the neurovascular system operates in some sensory capacity in the mediation of pressure and vibration, and this accounts for "spot" sensitivity. However, spatially considered, we might better think of this as a small skin region with a peak of sensitivity surrounded by less sensitive regions. This is in harmony with observer reports when one attempts to locate "spot" sensitivity. And these experiential descriptions parallel closely the descriptive makeup of the neurovascular structures.

One might explain the difference between "light" and "heavy" pressure in terms of the intervening distance from the point of stimulation to the locale of the glomic unit. This distance may be horizontal, vertical, or both. "Heavy" pressure may result from a more adequate stimulation of the glomic unit, and "light" pressure may be experienced when this mechanism is less adequately stimulated. Or again, these differences in the degree of pressure sensitivity may in part be due to the relative sizes or shapes of the glomus bodies being stimulated. Similarly, differences in the thresholds of vibratory sensitivity might be partly accounted for on this type of spatial basis.

It has long been recognized that on some parts of the skin there exists a relationship between the location of pressure spots and hair follicles. Frequently one will find pressure-vibration spots on the "windward" sides of hairs. That one finds glomus bodies located near the base of hair follicles on the "windward" sides has been shown from some of our experimental biopsies and from punch biopsies taken from surgical specimens. For example, in one of our experimental biopsies a good pressure-vibration spot was located near the base of a hair, and this hair, when moved, elicited a good sensation of pressure. When the hair was stimu-

lated by mechanical vibration, it was found that the threshold for eliciting the sensation of vibration was low compared to the stimulation of other hairs which did not have good pressure spots near them. Upon excising this hair and the tissue containing the pressure-vibration spot near its base, a portion of a glomus body was found very near the base of the hair follicle.

In an earlier paper the writer pointed out the possibility that hairs may work as levers, in certain hairy regions of the skin, in transmitting pressure and vibration stimuli to the "appropriate receptor." The writer now believes this receptor to be the glomeric unit of the neurovascular system. However, all hairs do not elicit sensations of pressure when stimulated, and this may be expected, since many hair follicles are not near glomus bodies. On hairy regions of the skin many pressure-vibration spots are found in areas some distance from hairs, and, of course, some of the hairless regions of the body, palms of hands, lips, etc., are very sensitive to pressure and vibration. Therefore, it is the contention here that the hair mechanisms do not function as primary receptors for the pressure and vibration stimulations, but act as mechanisms of a second order that help transmit the stimulations to the deeper-lying glomus bodies.

Other Possible Sensory Functions of the Neurovascular System

In the nine experimental biopsies described in Part II of this paper, it was reported that four of the excised areas were sensitive to temperature. In addition to containing pressure-vibration sensitivity, two of these four biopsies were cold sensitive and two were sensitive to warmth. A comparative examination of all of the biopsies shows that there are certain structural differences found between the tissues of those biopsies sensitive to temperature and those comparatively insensitive to temperature. The writer now has experiments under way which seem to indicate that in addition to serving in the mediation of the pressure-sensitive qualities, portions of the neurovascular system also function differentially in the mediation of temperature sensitivity. A report on these studies will be published soon.

VI. SUMMARY

Aside from such inadequately supported guesses as that Meissner corpuscles and the corpuscles of Pacini may function in the reception of pressure and vibration, little consideration has been

given to the possible pressure-vibration receptors. A review of the literature shows that the attempts that have been made to establish correlations between the various cutaneous sensory qualities and their possible receptors have, on the whole, been inconclusive.

In this paper seven direct excisions of cutaneous pressure-vibration spots and two "control" excisions of spots relatively insensitive to the pressure qualities are described. An analysis of these nine biopsies leads to the assertion that the cutaneous pressure-vibration sensations are mediated by the arteriovenous anastomoses or the glomic units of the neurovascular system of the skin. A brief history and a structural account of these mechanisms are given. Other evidences in support of the postulation that the glomus body serves as a receptor, if not *the* receptor, of cutaneous pressure and vibration are presented.

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THE BERNREUTER PERSONALITY INVENTORY: A REVIEW OF RESEARCH

BY DONALD E. SUPER

Clark University

The Bernreuter Personality Inventory has, almost since its publication in 1931, been the most widely used and thoroughly abused instrument for diagnosing personality. Because it yielded scores first for four, now for six, personality "traits," and because the names assigned these traits have been familiar to psychologists and educators, the Inventory found a ready market and has been used by many practitioners and in many investigations.

Some of these research studies have been disappointing because they failed to find clearly significant differences between employed and unemployed, between successful and unsuccessful, between maladjusted and normal, individuals. This lack of diagnostic value in the Bernreuter was doubly disillusioning because of the recent emphasis on the importance of personality traits in academic, vocational, and social adjustment. Intelligence test scores having been shown to yield imperfect correlations with the various criteria of success, it had been repeatedly pointed out that these discrepancies between prediction and fact were due to nonintellectual, personality factors. When objectively scored inventories of personality traits became generally available, psychologists, school administrators, and vocational counselors looked to them to improve their predictions, to complete their regression equations. It was also thought that they would provide a short cut in the selection of individuals needing treatment for personality problems.

When investigations failed to yield clear-cut results or contradicted each other, when clinicians and teachers found that the test results seemed to have little relation to other factors which they observed, one heard the Inventory condemned outright by many of its users. Brotemarkle's title, "What the Bernreuter Personality Inventory does not measure" (15), reflects this attitude; so do Strang's comments: "The Bernreuter Personality Inventory within the past five years has been subjected to a storm of unfavorable comment and convincing destructive criticism" (128, p. 214).

In spite of these facts, the Personality Inventory continues to be used in both practice and research. The attached bibliography includes all but a very few known studies (which do not seem to

add anything to our knowledge of the instrument) and shows the following trends in publication: in 1932, 7 distinct published studies; 1933, 21; 1934, 19; 1935, 23; 1936, 17; 1937, 12; 1938, 18; 1939, 8; and 1940, 8. It seems that publication reached its peak in 1935, declined, rose again in 1938, and was stabilized at a somewhat lower, but still fairly high, point during the last two years.

A total of more than 135 different published studies using one psychological test is an impressive record. This, combined with the fact that the Bernreuter was the best-known test in Pallister's (96) canvass of American psychologists and is typical of the inventory approach, has made it seem especially worth while to assemble in one place the important findings concerning the Inventory and to analyze them in order to achieve a better understanding of its defects, possible values, and practical uses.

DESCRIPTION OF THE INVENTORY

Personality Inventory, by R. G. Bernreuter, Pennsylvania State College, was published by the Stanford University Press, Stanford University, California, in 1931. (\$1.75 for 25; \$3.00 for 50; \$5.50 for 100.)

Purpose. To measure six traits: neurotic tendency (B1-N), self-sufficiency (B2-S), introversion (B3-I), social dominance (B4-D), self-consciousness (F1-C), and solitariness (F2-S). B1-N, B3-I, and F1-C are practically identical. Designed for use with adolescents and adults.

Contents. Consists of 125 questions based on those in questionnaires previously constructed by Thurstone, Allport, *et al.* Answers are recorded by encircling one of three possible responses: "Yes," "No," "?" Example: "Are your feelings easily hurt?"

Administration. Self-administering, group or individual. Interpretation of items is left entirely up to examinee, except for unprejudiced explanation of unfamiliar words when found. No time limits; probable maximum required is 30 minutes.

Scoring. A separate stencil for each trait. Weights ranging from +7 to -7 are assigned to each item according to its diagnostic value as determined by the Kelley-Cowdery-Strong method. The algebraic sum of the weights on a particular key corresponding to the responses encircled by a given individual constitutes his score for that trait.

Norms. Norms are provided which enable one to convert raw scores into percentiles for male and female adults, college students,

and high school students. Several investigators agree that Bernreuter's norms are adequate (95, 98, 117, 124), although two have disagreed (99, 145).

STANDARDIZATION AND INITIAL VALIDATION

The essential data on the standardization of the Inventory are given by Bernreuter (9). The test was standardized on criterion groups which had been selected as extreme by other inventories, namely: the Thurstone, Laird, Allport, and Bernreuter's S-S scale. The 50 most extreme cases were used for each trait. The correlations of Bernreuter's four keys with the criterion tests, from which many of his items were taken, range from .67 to .94, a substantial degree of validity if the original inventories are adequate. Kuznets' (68) criticism of the Inventory's validity, based on his conclusion that many of Bernreuter's items were "evidently taken from the tests used in validating the Inventory" (a fact made clear by Bernreuter), is beside the point. What is important is that, if the other tests are valid, this one probably is also.

Reliability

Four studies report reliability coefficients calculated by the split-half technique. Bernreuter (9) found that they ranged, when corrected, from .83 to .88 for the different scales, the mean being .86. Stagner (117) reported similar figures, ranging from .67 to .79 and correcting to .80 to .88. Frank's (49) data agree with the above, the range being from .77 to .86. Dudycha (36) reported coefficients ranging from .83 to .88.

Frank (49) also obtained retest coefficients, based on 35 cases, ranging from .77 to .86. Bills and Ward (13) reported retest reliabilities after one year on a sales job ranging from .65 to .72. Paterson (98) reported similar figures, the lowest being .70 and the highest .87. Lentz (75) found retest reliabilities ranging from .90 to .92. As several of the above have pointed out, these are high enough for use with groups, but suggest that caution is necessary with individuals.

Farnsworth (42) has studied the stability of Bernreuter scores over a longer period. He tested 319 Stanford freshmen, retesting at intervals of one, two, and three years. He found no significant changes on any of the six scales, although the coefficients decreased slightly with time, a change which he attributes to cultural factors rather than to the test. Coefficients after one year ranged from .70 to .77; after two years, .56 to .74; after three years, .44 to .72. After one year 71.45% of the items were answered in the same manner; after two years, 65.45%; after three years, 64.91%. These figures compare not too unfavorably with the retest coefficients of intelligence tests. Lentz found that, although about 20% of the reactions to specific items changed on a retest, 81% of these changes neutralized each other, having little effect (75). The pattern of response was reliable.

It has occasionally been claimed that supposedly significant scores could be made by checking items on the Inventory in a chance manner. Burnham and Crawford (18) threw dice in order to check this claim and found that scores tended to group between the 50th and 90th percentiles: the dice, in other words, tended to be slightly maladjusted. Bernreuter, on the other hand, has twice reported contrary findings after card-shuffling and a comparison with genuine scores (10, 12). In one study, for instance, he compared the dispersion of chance scores with that of actual scores made by college students and found them to be so different that he concluded the latter must reflect genuine factors in the individuals (12).

Validity

Items. The validity of the items in the Inventory has been considered by Bernreuter and by the authors of the tests on which his is based. Items were chosen on logical grounds, because they described types of behavior known to have certain psychological significance in clinical studies. They were validated by the method of internal consistency—that is, by the degree to which each item agreed with the general trend of the items. A study of the items important in his B3-I scale, for instance, led Bernreuter to the conclusion that it measured autistic thinking, introspection, and other types of behavior typical of introversion in its abnormal manifestations (9).

Landis and others have criticized this method of selecting items on the grounds that it is logical, not psychological (71). In one study he and Katz (70) reported that roughly three-fourths of the self-descriptive items, as checked by neurotics, agree with the objectively determined facts. In a subsequent study, however, he and others (71) made an item analysis of the Inventory to discover whether abnormals actually differ from normals in their responses. Contrary to logical expectation, they found that more normals than abnormals reported a tendency to daydream, to cross streets in order to avoid meeting people, to have ideas run through their heads, etc. Apparently these truly neurotic symptoms are incorrectly reported by the neurotics, and normal persons believe they have them when they do not, relatively speaking. Thus, the logical approach breaks down, and an empirical approach yields unexpected results. Mosier (91) has elaborated on this topic.

Revising the scoring method on this empirical basis, Landis and his colleagues found that abnormal persons were differentiated from normals (71). This raises another question concerning methods of validating such inventories: Should they be so constructed

as to distinguish abnormal from normal individuals, rather than normal individuals with abnormal tendencies from those who are well adjusted? If it is assumed that normals and abnormals are, in fact, on a single continuum, the question may seem irrelevant, for a test capable of doing one should automatically do the other. At the same time, it should be clear that the very existence of a severe maladjustment may render an abnormal person incapable of responding to inventory items in the same manner as a more or less normal person. This would account for the unexpected answers which Landis found to some of the Bernreuter items and suggests the possibility that normal, well-adjusted individuals may respond in agreement with logical expectation, that normal but poorly adjusted persons may respond in the manner expected of neurotics, and that abnormal persons may respond in a manner contrary to logical expectation to some items, for compensatory reasons. This hypothesis seems plausible in the light of known facts and should be worth checking; it means, in effect, using two different types of "abnormal" groups. If it is correct, Landis' empirical approach would be as misleading with normal individuals as Bernreuter's logical method is with psychotics, at least in the case of some items. That this is so is suggested by the apparent failure of the Neymann-Kohlstedt inventory, standardized on abnormal cases, to be superior to the Bernreuter.

Abnormal Subjects. Apart from the validity of the weights given certain items in the Inventory there exists a broader question, namely: the ability of the test as a whole to distinguish normal from psychotic and neurotic individuals. We have seen that the empirical scoring method of Landis and associates did do this; will Bernreuter's logical methods do so too, in spite of defects in some details?

Marshall (79) was the first to publish data bearing on this question. She gave the Inventory to 371 patients, 106 of whom were neurotics and the balance various types of psychotics. She reported that 50% of the neurotics were more neurotic and more self-sufficient than 80% of the normal population, 20% of the men and 10% of the women making higher scores than any subjects in Bernreuter's normal groups. Of the epileptics, 70% were less self-sufficient and less dominant than 50% of the general population. Of the schizophrenics, 80% of the autistic males and 60% of the autistic females exceeded the 50th percentile, and the paranoid were all below the 50th percentile in neurotic tendency. The

manics were all below the 50th percentile in introversion, and the depressed cases were above the 80th percentile. Addicts and behavior problems resembled normal individuals.

Yu (147) administered the Inventory to 127 schizophrenics and 34 manic-depressives and found the former more introverted, neurotic, and submissive. The differences were not sufficiently clear-cut, however, for differential diagnosis.

Landis and Katz (70) reported on the use of the Bernreuter with two different groups of subjects. The first consisted of 184 house patients and 40 out-patients, all coöperating voluntarily. Blanks were scored for neurotic tendency. Of the neurotics in this group, 38% scored between the 90th and 100th percentiles, 65% being above the 70th. Among the schizophrenics, 23% were above the 90th percentile, and 48% above the 70th. No manics were above the 50th percentile, and 20% and 48% of the depressed cases were above the 90th and 70th percentiles, respectively. These findings are in general agreement with Marshall and with Yu. In the second phase, however, which is not reported in detail, the picture is not quite the same. This time 250 different individuals were tested. The 18 scoring highest on B1-N were selected, together with the 18 scoring lowest: 9 of the former group were found to be normal and 9 neurotic, while 6 of the latter group were normal and 12 were neurotic. Landis' and Katz' comments on this material are rather glum, but, apparently partly on the basis of unreported data, they summarize by saying that high scores on B1-N are indicative of neurotic tendency, while low scores do not necessarily mean that those individuals are not neurotic. Thus the Inventory does appear to have discriminating value, as reported in three independent studies.

A fourth study dealt with this same topic. In it, Landis, Zubin, and Katz (71) reported on 125 normals, 28 neurotics, and 97 psychotics. None of the abnormal groups was differentiated from any other, and the critical ratios of abnormals and normals on the B1-N, B2-S, and B4-D scales were .57, 3.14, and 1.49, respectively. This study cannot be directly compared with the preceding without a reworking of the data, but it is clear that in this case B1-N is of no value in distinguishing normal from abnormal persons, whereas in the others it was. Several possible reasons suggest themselves. The first two studies differentiated between neurotics and psychotics of various types when classified and contrasted with normals, whereas this last study lumps the abnormals together.

As the earlier studies showed differences in different abnormalities, according to logical expectancy, it is difficult to justify this lumping procedure. Secondly, the numbers in the earlier studies, especially Marshall's, are larger. Thirdly, the comparisons of distributions are more likely to reveal trends than the critical ratios, important though these latter are in determining their significance.

Farnsworth and Ferguson (43) have reported some of the details of a case of suicide, a superior, "normal" student whose scores one year, and again one year later (three months before suicide), are given below:

	Percentiles	
	First Test	Retest Before Suicide
B1-N	50	83
B2-S	85	87
B3-I	43	78
B4-D	33	25
F1-C	33	77
F2-S	88	98

As the authors point out, the shift toward the unwholesome extremes is clear-cut in all but self-sufficiency (B2-S). They suggest that periodical retests, in order to detect trends indicative of a need for therapy, should be valuable.

Hathaway (56) reported on nine psychopathic inferiors, all of whom were either in the "best" 10% of the B1-N scale or off-scale entirely. He suggests, therefore, a possible diagnostic significance of so-called extremely stable scores: those nearer the average would accordingly be the most desirable. A new scale for psychopathic inferiority is being developed, based on this and on the Humm-Wadsworth.

Brown (16) found that, contrary to clinical expectation, drug addicts were not differentiated from normals by their introversion scores. Patterson and associates (98) reported from a clinical check that the test tended to select neurotics and psychotics, but missed many maladjusted cases who made "good" scores.

In summing up these studies, it seems necessary to disagree with the final verdict of Landis and his associates. When the data are examined in detail, they do appear to reveal differences between normal and various groups of abnormal individuals, even though these differences are not so clear-cut as one would wish. As Landis himself wrote after his earlier study, unfavorable scores do tend to have significance, although favorable scores are not necessarily a sign of good adjustment. Hathaway's study suggests the desirability of scores near the mean.

Behavior Problems. Six studies consider the value of the Bernreuter in predicting problem behavior.

Marshall's (79), already mentioned, failed to find any differences between hospitalized behavior-problem cases and normal individuals. Speer (114) compared 58 problem children at the Mooseheart Laboratory with 184 controls, using all four B scales. He found no significant differences. Keys and Guilford (67) administered the Bernreuter and a number of other inventories to 261 ninth- and tenth-grade boys and correlated these with Haggerty-Olson-Wickman ratings. The coefficients for B1-N, B2-S, and B4-D equaled -0.04 , $.07$, and $.15$, respectively, the last being reliable. Nottingham (94) found no personality differences in unmarried mothers. Mathews (80), however, found that his "good behavior" group was significantly lower on F2-S than his "poor behavior" group. Horsch and Davis (59) found that penitentiary inmates were more neurotic and introverted than those in reformatories and than normal individuals.

From these studies we may conclude that, whatever the traits the Bernreuter is measuring, and however adequately it may measure them, the Inventory is of little practical value in selecting behavior-problem cases, although they do seem to indicate that persons with certain types of personality patterns are more apt to develop some types of problem behavior than are others. Clear-cut differentiation is unlikely because of the complexity of both personalities and the situations in which they are found.

Personnel Problems. College students who were poor readers, who came voluntarily for personal help, or who were enrolled in mental hygiene courses, were tested by Stogdill and Thomas (124), the total group numbering 413. Taken as a whole, the distribution was similar to that of the norms. When classified, the voluntary cases were the most neurotic, followed by the poor readers, according to logical expectation.

St. Clair and Seegers (123) tested 729 men and 433 women freshmen at Temple University. The scores of those who were expected to deviate, on the basis of a questionnaire filled out by all, were tabulated and were consistently above the 50th percentile in neurotic tendency. Those requesting interviews concerning problems of family relations made a mean rating on B1-N at the 73rd percentile; those wanting interviews concerning financial problems, to cite just one other case, ranked at the 51st percentile. Those who were earning part of their expenses were more self-sufficient, and the leaders in college activities made better balanced scores in all areas. In another study, the same authors (122) analyzed the F scales developed by Flanagan (47) for Bernreuter's Inventory. Here they report that the picture given by the whole profile is more significant than the score on any one scale. Two types of profiles are described, one indicative of a withdrawing personality, the other of leadership. The former profile is high in neurotic tendency, low in dominance, and higher in self-sufficiency; the latter profile is low in neurotic tendency, high in self-sufficiency, dominance, and solitariness. Farnsworth (41) has called attention to three modal profiles, the most common being: lowest third of B1-N, highest B2-S, lowest B3-I, and highest B4-D.

Bloom (14) related Bernreuter scores to personal data for 243 students. Extracurricular activity had no relationship to any of the scales, but fraternity members were more stable, dependent, and dominant than others. Earners were self-sufficient and dominant. High B1-N students did not think of themselves as more nervous than others, but they indicated that they worried more. Submissive students had more ailments than others. Hunter and Jordan (60) found leaders more self-sufficient, more dominant, than other students.

Jarvie and Johns (61) obtained ratings from faculty members who knew students intimately and found correlations ranging between -.15 and .14. Other data led them to conclude that the Inventory was of no value in student counseling at the Rochester Mechanics Institute. Johnson (62), on the other hand, felt that it had constructive value in counseling work as one part of the clinical picture, as did Anderson (4), whose study is referred to in connection with occupations, and a number of members of the New College (Teachers College, Columbia University) faculty (104).

Fisher and Hayes (46) compared the results of Bernreuter scores given to entering women freshmen with psychiatric diagnoses made as a result of referral by instructors for suspected serious maladjustment. Significant and reliable relationships were found between serious maladjustments and high scores on all traits but dominance.

Coiner (27) administered the Bernreuter to college students and compared the scores of cheaters with those of noncheaters. She reported that "crippers" were more neurotic, less self-sufficient, and more introverted. Those who did not admit they cheated varied more from the normal than did those who admitted it. A study of Campbell's (21), involving 173 students, agrees on self-sufficiency and is less clear-cut elsewhere.

Attitudes. McMurry (82) administered the Bernreuter Inventory to 196 bank employees, who also filled out a job satisfaction questionnaire and were rated for efficiency. The neurotic scale was found to have a low negative correlation with efficiency ratings and with poor work attitudes. It added nothing to Otis scores in correlations with efficiency. McMurry interprets this as indicating that personal maladjustment is generally overemphasized as a cause of vocational dissatisfaction.

Dexter (31) correlated Lentz radicalism scores with Bernreuter's scales and found unreliable r 's ranging from -.045 (B1-N) to .227 (B4-D). A multiple coefficient of correlation of radicalism with self-sufficiency (B2-S), low speed (Downey), and a 400-item information test equaled .864. Radical college women had good personalities, although the correlations were low.

Symington (133) used the test in a study of religious liberalism and found no relationship between Bernreuter scores and liberalism. An analysis of the items, however, showed that there was a relationship between the self-sufficient-introvert type of item and liberalism, when these were separated from the more purely neurotic type of items. The discussion of traits, below, takes up this question of the purity of Bernreuter's traits; it need only be said here that the difference found by Symington appears to agree with other findings. This being the case, the impurity of the trait

has probably hidden genuine group differences in religious attitudes and adjustments.

Marital Happiness. Johnson and Terman (64) found the happily married more stable and extraverted, while divorced women were self-sufficient and dominant. Bernard's (7) findings agree and also show that neuroticism in the wife makes for unhappiness in the husband.

Family Resemblance and Friends. Terman (135) used the Bernreuter as one of the instruments in his study of marital happiness. While the coefficients for traits among couples were low, they were also consistently positive. In the unhappy group they ranged from .121 to .289, in the happy group from .074 to .241, for the various scales. Two of the "unhappy" coefficients and one of the "happy" were reliable. Apparently, married couples do tend slightly to resemble each other in the traits measured by Bernreuter, a finding in accord with other data of Terman's.

Other studies tend to agree with that of Terman and his associates. Sward and Friedman (131) found a coefficient of .34 for Jewish couples and of .12 for non-Jewish (56 couples each). Crook (29), studying 79 couples, found coefficients ranging from -.05 to .06. Hoffeditz (57), with 100 couples, reports a low positive relationship. Kelly (66), testing 300 engaged couples, found no significant relationships. Richardson (106) has summarized eight such studies, using various inventories, and found that the coefficients ranged from -.05 to .34, with a mean of .14. The Bernreuter agrees, then, with other inventories on this matter in finding low positive correlations. Van Dyne (139) found girl friends similar to each other only in dominance and sociability.

Hoffeditz (57) also considered other members of the family. All the relationships were low, the highest and lowest being those one would expect on psychoanalytic grounds: mother-daughter equaled .267 and .284 on B1-N and B4-D, respectively; mother-son, .024 and .053 for the same scales. Carter (23) studied 133 sets of twins and found that monozygotic twins were more similar in B1-N, B2-S, and B4-D than are others; that like-sex fraternal twins were more similar than unlike-sex twins in B3-I but less so in B1-N and B4-D, and that they had a negative coefficient for B2-S. The data for the identical twins are what one would expect, but the scores on all but B3-I are difficult to explain for the nonidentical twins. On the whole, however, the data on family resemblances seem to indicate a moderate degree of validity in the Inventory.

Family Constellation. Eisenberg (39) used the Bernreuter in a study of factors relating to feelings of dominance among persons of college age. He found that oldest and only children were more dominant than others. Meenes (84) found that youngest children were more dominant, self-sufficient, and less neurotic than others. Abernethy (1) found oldest children more dominant, less neurotic, than others; middlers less well adjusted than eldest children; and only children inconsistently more self-sufficient, dominant, and less unstable. Campbell (20), Stagner and Katzoff (120), and

Witty (143) found little relationship between birth order and Bernreuter scores. The first two found only children more self-sufficient; Campbell found them more unstable; Stagner and Katzoff's older children of two were more stable than the youngest of several. The latter agree that birth order in itself is meaningless, other elements in the constellation being more important. Stagner (119) made a study directly concerned with the effect of the role of parents in personality development. His findings were in general agreement with Freudian theory, the males who preferred their mothers being less stable than those with father preferences. Stagner refers this instability to the social norm of father identification.

Social Groups. A number of differing types of social groups have been compared by means of the Bernreuter scales. Occupational, including unemployed, groups will be dealt with in the next section. Hargan (54) studied a group of convicts and found that they were highly extraverted. This would seem to agree with Hathaway's data on psychopathic inferiority, previously mentioned, and with theory in that the offender against society would be one sufficiently extraverted to become actively aggressive rather than seek escape in withdrawal. Horsch and Davis (59), however, found penitentiary inmates more neurotic and introverted than the norm. That this finding suggests possible schizoid-paranoid trends may indicate the need to consider more adequately the type of crime and the situation leading to it. Different personalities may commit similar crimes because of different situations.

Shen (113) compared Chinese and American students and found the former more introverted, less self-sufficient, and less dominant. He attributed these tendencies to a greater emphasis on modesty in Chinese than in American culture. Farnsworth (42) reported that foreign students were less dominant than Americans in their earlier years in this country and became increasingly dominant with longer residence. Jewish students were more dominant than the norm. Sward and Friedman (132) compared 625 adult Jews with an equal number of non-Jews and found that 60% of the Jews exceeded the average Gentile in instability. Eisenberg (39) also found Jews more dominant, as were the children of men in business and the professions and children in private schools.

Negro-white differences have been studied by Meenes (84), Eagleson (37), and Patrick (99). On B1-N negroes were found to make lower scores than whites (99); on B2-S, higher (37, 84, 99); on B3-I, lower (84, 99) and no difference (37); on B4-D, higher (37, 84, 99); on F1-C, lower (84) and possibly higher (37); on

F2-S, higher (37, 84). There is, thus, substantial agreement on this type of comparison.

The above data indicating cultural differences in personality agree with clinical material and logical expectation, and can be taken as indicating the validity of the Inventory in studies of this type. Stagner summarizes a study of parental roles in personality development thus: "The tendency is for children reared in homes conforming to the American scheme to grow up into personalities conforming to the American standard . . ." (116).

Two other studies probably belong in this category, although they deal with a physical handicap. Welles (141) administered the Bernreuter Personality Inventory to hard-of-hearing, urban adults and to matched-hearing adults. The hard-of-hearing were less stable and extraverted and less dominant than the hearing controls, and the lip-readers were more stable than the non-lip-readers. The conclusion was that the better the contact with the environment, the more stable the individual. This agrees with the Bernreuter findings concerning foreign groups and with clinical knowledge and theory. Pintner (103) duplicated the study with small-town and rural adults, obtaining similar results and finding his isolated, hypacusic group less stable than Welles' urban group.

Occupational Groups. Persons employed in different occupations have been compared by means of the Bernreuter in several studies. The first of these was by Paterson, Trabue, and their associates at the Minnesota Employment Stabilization Research Institute (98). They reported that only dominance-submission differentiates occupational groups; salespeople were more dominant than those in unskilled, semiskilled, and skilled occupations; policemen were more dominant and also more stable and extraverted than others. The variation within groups was larger than that between groups. Dodge (33, 34) reported results which are essentially the same, with, however, no relationship between B scores and success. Salespeople were more dominant than clerical workers; traveling salesmen more so than bookkeepers; the critical ratios ($D/P.E.\cdot diff.$) equaled 5.9 and 9.1. No other scales revealed significant differences. Morton made a similar study in Montreal (89). He reported that stability was greatest in accountants, salesmen, carpenters, and electricians, and lowest in engineers and the unskilled. The mechanics and carpenters were least self-sufficient, the accountants and salesmen most so. These last were also the

most dominant along with professional men and executives, the engineers, semiskilled, and unskilled being most submissive. Super (130) found a low positive correlation between neurotic tendency and mechanical aptitude. These several studies appear to be in rather close agreement in finding the dominance scale most useful and in finding few group differences very great.

Bills and Ward (13) have reported a preliminary study of casualty insurance salesmen. Those succeeding in this work made more normal scores than those who failed in it. A study by Schultz (112) is in agreement with the above as to the value of the Inventory in selecting salesmen.

Anderson (4) made a clinical study of 40 Y.W.C.A. secretaries released during the depression. At least 70% of the group exceeded 80% of the general population in emotional stability, extraversion, self-sufficiency, and dominance. The exceptions were justified, in the clinician's opinion, by case data: they were less successful than the majority. She concluded that, properly interpreted, the Inventory does add to the counselor's insight.

In a study of 48 student nurses by Rhinehart (105), this group was found to exceed college women in instability and to make lower scores on self-sufficiency and dominance.

Motion-picture writers were studied by Metfessel (86) and were found to have traits comparable to those of the general population. It should, perhaps, be pointed out that the mean percentiles (males) of 69, 46, 63, and 33 do not conform to the modal profile noted by Farnsworth and previously mentioned, suggesting that this group does, in spite of considerable individual differences, differ somewhat from the average. Miller (88) found no relationships between the B scales and dramatic success. Carroll (22) correlated Bernreuter scores with ratings of artistic talent, Meier-Seashore, and McAdory Art Tests for 218 college students, obtaining low and unreliable coefficients, but finding a slight tendency for art talent to accompany introversion. Ratings for creative ability had a low positive relationship with neurotic tendency. Ability to appreciate and create art were not related to B1-N, B3-I, or B4-D.

Unemployed and employed workers have also been compared. Paterson and his associates, in the above-mentioned study (98), found no significant differences. Morton (89) found differences which were probably significant, the employed being more stable, more self-sufficient, and more dominant. Christensen (26) found

that employed men and college men were significantly more dominant than unemployed and that college men were more self-sufficient. The same differentiation was found for women on the dominance scale. The bulk of the evidence seems to agree with Morton's conclusion that the Inventory is valid for determining group trends in personality in the occupational field, although not for individual use.

Four studies have been published concerning Bernreuter scores and success in teaching. Cahoon (19) and Sandiford (110) found no significant differences between good and poor student teachers (as rated) on any scale. An item analysis, however, revealed 18 items yielding marked differences. Laycock (74) made a similar study somewhat later with four or more ratings based on practice teaching. None of the critical ratios were significant, but a comparison of the extreme quartiles did reveal great differences on all four B scales. Laycock concluded that the technique was a promising one. Palmer (97) reported that B1-N, B3-I, and B4-D distinguished the most successful from the least successful teachers of physical education, B2-S being doubtful. Differences were in favor of the successful teachers.

High school seniors interested in teaching were studied by Yeager (145). A control group larger than Bernreuter's high school group was found to average at about Bernreuter's 75th percentile on B1-N and closer to the 50th on the other keys. Because of this discrepancy, Yeager used the "general group," his controls, as norms (boys, N = 269; girls, N = 231). Those interested in teaching were, accordingly, close to the average on the three keys used, the means ranging from the 52nd percentile to the 54.9th percentile. According to the published norms, however, this would make them rather maladjusted, somewhat about the 75th percentile. Yeager is probably right in comparing them to other students in their own environment; but this leads one to wonder, in view of the general agreement with Bernreuter's norms, what sort of environment this was. Phillips and Greene (101) found that unmarried teachers were slightly more neurotic than married teachers.

Pintner (102) tested a class in mental testing, finding that those whose protocols and other data caused them to be rated as poor testers were more neurotic than successful examiners.

McMurtry (82) used the Bernreuter in a study of bank employees, scoring it only for B1-N. A slight negative correlation with efficiency ratings was found, but the Bernreuter scores added

little to the predictive value of the Otis test in selection. McMurry concluded that personal maladjustment is overrated as a cause of vocational maladjustment.

Physiological Factors. Omwake and her associates (95) correlated Bernreuter scores with various physiological measurements of 92 college women. The coefficients ranged from -.306 (B2-S and pulse) to .161 (B2-S and basal metabolic rate). Goldstein (52) and Stone and Barker (126) reported low correlations with biochemical tests. Morton (90) calculated correlations with morphological indices and failed to find any linear relationships. These findings seem to agree with others concerning physique and personality.

Stone and Barker (126, 127) compared premenarcheal and postmenarcheal girls by means of the Pressey Interest-Attitudes, Bernreuter, and Sullivan scales and found that the Bernreuter did not distinguish one group from the other, although the others did, and was not related to menarcheal age. As the tests measure different things, this fact is not significant, but it may be significant that the personality differences commonly supposed to result from pubescence are not reflected in the Bernreuter. In view of the general failure to find such differences associated with pubescence, this can hardly be taken as a reflection on the test. Dispensa (32) correlated Bernreuter and thyroid tests and reported a negative relationship between hyperthyroidism and neuroticism.

Age. Age differences have not been frequently studied. Bernreuter's norms show age differences too slight to be emphasized (9). Carter (23) and Miles (87) found no relationship between B scores and age, but Horsch and Davis (59) reported that self-sufficiency and dominance increased with age in criminals and in the general population.

Intelligence. Bernreuter (10), Carter (23), Brotemarkle (15), Finch and Nemzek (45), and Omwake, *et al.* (95) reported negligible correlations between the Bernreuter scales and intelligence. Greene and Staton (53) found only one significant correlation, -.33, between F2-S and the Ohio State test. Stagner (116) has reviewed other studies and reported negligible correlations between B scores and intelligence. Hollingworth and Rust (58), studying a group of adolescents with IQ's ranging from 135 to 190 (median 153), found this group more stable, self-sufficient, and dominant than the controls. Wrenn (144) reported that the very superior student was no more stable, but more self-sufficient and dominant, than the inferior student. This apparent difference is probably explainable on the basis of differences in methods, as comparisons involving extreme groups frequently reveal differences not shown in correlational studies. It seems quite possible that very bright children may tend to have good personali-

ties without the relationship in average groups being close enough to show up in correlational studies. Indeed, this agrees with clinical evidence and other studies. St. Clair (121) has calculated the biserial coefficient of correlation between intelligence test scores and his "Profile I," withdrawing personality (B1-N, over 70; B4-D, below 30; B2-S, 25 points above B4-D), and found it equal to .40, indicating real promise in this global approach.

Achievement. Relationships between Bernreuter scores and school achievement have also been studied, as it was hoped that personality inventories would raise predictions of academic success. The correlational approach has yielded more or less consistently neutral results, as shown by Brotemarkle (15), Finch and Nemzek (45), Nemzek (93), Omwake, *et al.* (95), Engle (40), Greene and Staton (53), and Stagner (116). Nemzek also compared extreme cases and still found the test of no differentiating value, but Greene and Staton and Stagner found low achievers less self-sufficient than others. Neel and Mathews (92) found that high-achieving superior students were more introverted, self-sufficient, and solitary than nonachieving superior students. Although these findings do not agree with those reported in early studies, they do agree with later findings with other inventories. The traits measured by personality inventories do not have any direct bearing on success in school and college, although low correlations in the 20's are occasionally reported (128). As Stagner concluded (116), personality affects achievement by influencing the use made of one's abilities and, therefore, does not yield a linear correlation with achievement. It is, however, related to study habits, B1-N, B3-I, and F1-C correlating -.32, -.41, and -.41 with Wrenn's Study Habits Inventory (144).

Ratings and Case Studies. The self-sufficiency scale was the first developed by Bernreuter (8). This was correlated with ratings by associates, the coefficient being .54. Bernreuter also correlated the B scores with self-ratings which had a low reliability and found relationships expressed by coefficients ranging from .56 to .67. Casselberry (25) obtained a correlation of .52 with self-ratings of social adjustment. With ratings by others, the coefficient was -.47. Roberts and Fisher (107) reported a coefficient of $.32 \pm .10$ for B3-I and ratings based on half-hour interviews. Burks (17) had college freshmen women rated by eight hall officers and others in a position to know them. The correlations were .21, .15, and .43 for B1-N, B4-D, and B2-S, respectively. Four out of five girls above the 90th percentile in self-sufficiency were recognized as

such by all eight raters. Where discrepancies occurred, individual analysis revealed adequate reasons.

Stagner (116) tested 230 freshmen at the University of Wisconsin, over 100 of whom called (by invitation) to get their scores. These were interpreted by Stagner, the students commenting. The investigator took notes, rating the men on the basis of the interviews. B1-N was found to have a high degree of validity, scores above the 90th percentile indicating maladjustment and low scores meaning good adjustment. B2-S was also found valid, high scores indicating intellectual independence. B3-I resembled B1-N. B4-D was found fairly valid. Turney and Collins (138) found a close agreement between Bernreuter scores and diagnoses of normal high school students based on case studies.

Objective Tests. The relationship of B3-I scores to results of a mirror-tracing test was studied by Roberts and Fisher (107). The coefficient was $-.25 \pm .11$. Mirror-tracing, correlated with judges' rating of extraversion (described above), yielded a coefficient of $.915 \pm .02$. Ryans (109) administered Bernreuter inventories and persistence tests to 40 college sophomores and found persistence positively related to stability, extraversion, and self-sufficiency.

Suggestibility has been correlated with Bernreuter scores by Bartlett (5) and by Messer (85), using Hull's test. No relationships were found. Classifying his subjects (52 normal and abnormal individuals), Bartlett found relationships between suggestibility and submission in psychoneurotic and between suggestibility and extraversion in normal persons. The numbers, however, were small, with a total group of 52.

The Kent-Rosanoff Association Test was used by Laslett and Bennett (73), who found no relationship between it and B1-N scores, and who concluded that they either measure different things or measure them in different ways. Rorschach Inkblot scores for 52 college students were analyzed by Vaughn and Krug (140). Affective stability and neurotic tendency were correlated to the extent of $-.52$; introversiveness and introversion, $.78$. In view of the complete lack of similarity in testing techniques, these correlations, if confirmed by other investigations, constitute important evidence of the validity of pattern scores based on subjective responses. Partial confirmation is to be found in the common factor of emotional stability in both tests reported by Line and associates (76).

Local information ("gossip test") and Bernreuter scores (B3-I) were correlated by Davis and Rulon (30), who concluded that the former, because it was not related to B3-I scores, was not a valid test of introversion. We cannot draw conclusions concerning the validity of the Bernreuter Inventory, in which we are interested, as it was correlated with a test of unknown significance. Dudycha (36) found stability and self-sufficiency related to punctuality. Phillips and Greene (101) found a correlation of $.77$ between B1-N and Bell total adjustment scores. Adams (2) studied experimentally induced frustration in 450 college freshmen.

Those diagnosed as neurotic by the Bernreuter differed neither in efficiency of performance nor in susceptibility to frustration. They did, however, display more agitated behavior and gave more alibis for failures. The first findings were presumably due to a frustrating situation not sufficiently important to disorganize behavior in anyone.

Effect of Experience. Rose (108) compared pretests and retests of 291 speech students and 291 paired students in nine colleges. The experimental (speech) group showed a greater decrease in neurotic tendency, a greater increase in dominance, but no differences in self-sufficiency and sociability. Turney and Collins (138) found that 21 high school students of psychology, who did not study personality measurement, showed significant improvement on all keys over their controls. These findings are in accord with the experimental studies of the modification of personality, but it seems likely that test sophistication has affected the Turner-Collins study despite their attempt to control it.

Effect of Mood and Rapport. The Inventory has frequently been criticized as a self-rating technique, subject to all the weaknesses and defects of self-ratings. Few attempts have been made to check the validity of these criticisms. Bernreuter (10) reported that scores on his Inventory were not affected to any appreciable degree either by the desire to do well or by a desire for social approval, as evidenced by a comparison of standard situation scores with retest scores after instructions were given to answer (a) "as you would like to be," and (b) "as you think you ought to be." Landis and Katz (70) found that most of the self-descriptive statements of neurotics taking the Inventory were true when objectively verified. Johnson (63) worked with a group of 15 college women in carefully controlled conditions, getting them to take the Inventory when in subnormal and supranormal moods. None of the critical ratios was clearly significant, the range being from -2.3 to 1.1. They were, however, in the expected directions, low mood being accompanied by shifts toward neuroticism, dependence, and submission. The lack of significance is attributed to a fixing of responses the first time the test is taken. Whatever the reasons, it is clear that responses to Bernreuter items are relatively stable and unaffected by mood and other factors. No one has tried to get shifts in predetermined directions, as has been done with Strong's Vocational Interest Blank, but, as those changes were obtained as the result of conscious effort obtained by rapport with the examiner, such a test is not so important for practical purposes as those already applied.

to the Bernreuter. Hartmann (55) found that courses in educational psychology produced what may have been significant differences (98/100) in B1-N scores, which suggests that test sophistication may affect self-report. Metfessel (86) compared unsigned Bernreuter tests for 139 unselected adults with the norms and found that the former portrayed themselves as rather more neurotic, introverted, and submissive. This agrees with Spencer's (115) thesis to the effect that signing one's name does cause one to improve one's score. When a personality inventory is to be identifiable, rapport must clearly be the best possible. Lorge (78) reported individual tendencies to check largely "yes," "no," or "?" responses to the exclusion of others. The effect on scores was not shown.

THE TRAITS MEASURED

Bernreuter developed four scales for the scoring of his Inventory, each of them purporting to measure a different trait (9). Two others, found to underlie these four, were published by Flanagan (47), and a seventh has been described by Schlaudeman (111). This last, however, was found to correlate highly with B1-N, B3-I, and F1-C. The intercorrelations of the other scales have been calculated by various workers, Bernreuter (9), Brotemarkle (15), and Stagner (117), to cite just three investigators, agreeing that B1-N and B3-I measure practically the same thing and that these have a rather high negative relationship with B4-D. Thus, only B1-N and B2-S, and possibly B4-D, of the Bernreuter scales, can be said to measure independent traits. Flanagan's factor analysis and the two resulting F scales (47) fit in with this correlational analysis, showing that two underlying factors account for the three or four apparent traits measured by the B scales. Also in agreement is Bernreuter's study (11), which reports finding an "emotional" factor underlying all of a group of personality inventories, plus a group factor in B1-N and B3-I. Perry (100) found emotional, sufficiency, and dominance factors in 10 personality tests. Line and associates (76) reported a common "stability" factor in the Bernreuter and the Rorschach tests.

Numerous studies have been made with this and other inventories in order to determine just which traits, if any, were being measured, and the subject is still a debatable one. Vaughn and Krug's study (140) suggests that the Bernreuter scales are measuring a real psychological entity and not just a statistical artifact, as

asserted by Lorge (77). The last-named investigator correlated the "yes," "no," and "?" responses, finding that they ranged from $-.78$ to $.72$, most of the coefficients being low. This led him to conclude that they were not measuring the same trait, especially as some intertrait correlations were higher than those within certain traits. Flanagan (48) criticized Lorge's conclusions, contending that low correlations between parts of a test do not invalidate the scale as a whole and have been considered acceptable in other tests. In addition to this fact, it should be kept in mind that some of the traits that Lorge was analyzing were related as wholes (B1-N and B3-I, for instance), and, therefore, it is to be expected that some parts would correlate more highly with parts of other traits than with parts of the same trait. Lorge condemned the Bernreuter outright, but on further investigation concluded that Flanagan's keys were both independent and consistent and, therefore, usable (77).

In practice, the three relatively independent Bernreuter keys continue to be used, either with or without the statistically superior Flanagan keys. The reason for this probably lies in the fact that the B scales appear to have greater psychological significance. We are used to thinking of emotional stability and of the other traits measured by the B scales, while the concepts of self-consciousness and solitariness, however familiar generally, have not been long current in psychometrics and have less clinical reality. If Flanagan had called his F1-C scale "emotional stability" or "extraversion" instead of "self-confidence," duplication of Bernreuter's names notwithstanding, the F scales might be more widely used!

The emphasis in this discussion has attempted to be consistently empirical. Before attempting to conclude, however, with a summary statement of what the Bernreuter can measure, it seems advisable to describe the psychological traits measured by the seven existing keys to the Bernreuter Inventory. The correlational studies make this also a somewhat empirical question. For a more complete and theoretical discussion, the reader must be referred to the recent books by Allport (3) and Stagner (118, Chap. 8). The latter has concluded that there are three "major traits of personality," corresponding to Bernreuter's emotional stability (sensitivity), self-confidence, and sociability scales.

B1-N appears to measure, more than anything else, emotional stability or sensitivity. A low score indicates a wholesome adjustment to the environment—what is often called extraversion be-

cause it involves the ability to face facts objectively and deal with them without internal conflict. High scores indicate a poor adjustment to the environment—what might be called unwholesome introversion, in which the individual tends to withdraw from contact with the outside world because of maladjustment in it. "Emotionality," although common in neurotics, is not exactly synonymous with "neurotic tendency."

B2-S probably measures the other type of introversion, at one extreme, and a type of extraversion not commonly thought of as such, at the other. The high-scoring person is "self-sufficient," is not dependent on others for advice and companionship, and is able to get along on his own with little difficulty. He is not "withdrawn," so much as free from the need to advance. He is an introvert in the original Jungian sense. The low-scoring person is not, it has been said, extraverted in the usual sense: this aspect of the continuum is measured by B1-N. In B1-N wholesome contact with the environment is contrasted with withdrawal from it because of maladjustment; in B2-S wholesome independence of environmental support is contrasted with unwholesome dependence on it. The low-scoring person on B2-S is, therefore, extraverted in the literal sense of the word, but he turns to the environment for emotional support rather than for natural outlets. To avoid confusion, it seems wise to continue to use "emotional stability" for B1-N and "self-sufficiency" for B2-S.

B3-I is identical with B1-N, and confusion will be avoided if this scale and its trait name are dropped. "Introversion-extraversion" has come to mean too many things.

B4-D measures the tendency to dominate in face-to-face situations. It is not a "pure" trait, but a composite made up of extraversion, as measured by B1-N, B3-I, or F1-C, and sociability, as measured by F2-S. Low scores indicate submissiveness, but high scores may, of course, be compensatory.

F1-C is a somewhat purer and more consistent measure of the trait assessed by B1-N. The contrasts are made clear below.

F2-S is a measure of sociability. It is more closely related to B2-S than to any other key, but is free from some of the confusion existing between the first two B scales. The F1-C continuum appears to consist of good contact with the environment as opposed to poor; the F2-S, of wholesome liking for contact with others in the environment as opposed to wholesome liking for freedom from such contacts. The F scales are thus concerned, the one with *type*

of contact, the other with *need* for contact, whereas the B scales confuse type and need.

S1-I, the unpublished Schlaudeman scale, is a measure of the extent to which a person differs from people in general in his responses to the Bernreuter items. It is thus a measure of idiosyncrasy, the significance of this deviation not being specifically indicated. Schlaudeman's study shows, however, that the deviations measured are comparable to B1-N and F1-C.

It now remains to draw whatever conclusions concerning the practical value of the Bernreuter Personality Inventory we can from the foregoing review of research with this measure. No attempt will be made to document statements in this section; it will be assumed, instead, that the necessary evidence is in the preceding pages and is now familiar to the reader.

WHAT THE BERNREUTER DOES AND DOES NOT MEASURE

The Bernreuter Personality Inventory has been shown to measure group trends with a reasonable degree of reliability; it can be used with individuals, but with some caution. Some of the items in the test are not suitably weighted for differentiating abnormal from normal individuals, but taken as a whole the items and the weights are adequate, especially when used with nonpsychotics. The Bernreuter scores tend to distinguish neurotics and various types of psychotics from normal individuals, although not perfectly; normals in the mass are not differentiated, because of the canceling out of extreme tendencies. Unfavorable scores are indicative of maladjustment, but "favorable" scores do not necessarily indicate good adjustment: they may, in some cases, indicate maladjustment, e.g. low neuroticism scores and psychopathic inferiority.

The Inventory is of questionable value in selecting behavior-problem cases: the interplay of personalities and situations is too complex. In student personnel work, those wanting advice on personal matters, those who cheat, those who are independent, those who tend to withdraw, and those who tend to be leaders are selected by the test. Profiles consisting of scores on all keys are especially helpful in diagnosis.

The Bernreuter is not helpful in selecting efficient clerical workers, and its scores are only slightly related to work attitudes. Religious liberals do apparently tend to make higher scores on solitari-

ness, and undergraduate radicals tend to be self-sufficient and otherwise normal.

The happily married are more stable and extraverted than the unhappy, the emotional stability of the wife being more important for marital happiness than that of the husband.

Data on family resemblances agree with logical expectations, couples tending to resemble each other slightly, parent-child relationships following the Freudian pattern, and siblings' resemblances in personality agreeing with the data on intelligence. Family constellation has the expected effects on personality as measured by Bernreuter: oldest and only children tend to be more dominant; those with opposite-sex parent fixations are less stable than those with like-sex identifications. Birth order, in and of itself, is, however, not very significant.

Social group differences are found in agreement with established facts and logical expectation. Some convicts are introverted and others are more extraverted, privileged groups have more desirable traits, foreigners new to a community are less dominant than those established in it, and those with physical handicaps which separate them from others are less stable than normal or less handicapped individuals. Negroes, although underprivileged, have apparently developed socially desirable traits.

Occupational group differences have been disappointing in that they are not so clear-cut as some have expected. There is considerable overlapping, suggesting that there is sufficient variety among the jobs in a given occupation to allow scope for all kinds of personalities in any occupation. In spite of this fact the tendencies are rather definite: those in work involving contact with individuals tend to be more dominant than others, whereas those working with records and objects tend to be less so. Differences in other traits have not been found to be reliable, and in no case are they great enough for individual guidance; other factors are of more importance. Unemployed persons tend to have less desirable traits than the employed, but again the tendency is not sufficiently clear-cut for application to individuals. There is no relationship between Bernreuter scores and success in some occupations, but especially successful teachers, Y.W.C.A. secretaries, and salesmen have been found to be differentiated in expected ways from failures in those occupations.

Data obtained by means of the Bernreuter agree with material

obtained in other ways, to the effect that personality traits have little relationship to physiological measures, except thyroid condition. There is no correlation with chronological age, nor with intelligence, as is logical in view of other evidence, but the expected prevalence of good traits among very intelligent persons is reported by investigators using the Bernreuter Inventory as well as by other types of studies. Bernreuter material agrees with other such studies in finding no relationship between measured personality traits and achievement, whether the analysis is based on correlations or on differences between extreme groups, personality traits affecting only the way in which one uses his ability.

Ratings of individuals, both by themselves and by their associates, have been shown to have a fairly high correlation with Bernreuter scores. Mood, self-interest, test sophistication, and the desire for social approval have less effect on test scores than is generally thought, although signing one's name on a personality inventory does appear to cause one to give a more socially approved picture of oneself. The writer suspects (on the basis of hiring experience) that employment applicants will be found to improve their scores appreciably, but objective evidence to this effect is not available.

Bernreuter scores have been found to be unrelated to suggestibility or to Kent-Rosanoff scores, but inventoried stability and introversion are related to Rorschach-tested stability and introversion, to tested persistence, and to punctuality.

This brief synthesis of findings concerning the Bernreuter Personality Inventory points to the conclusion that it has considerable validity as a research instrument; that when properly used it has some value in work with individuals; that in either type of work care must be taken to secure adequate rapport; and that some situations may be such as to make such rapport out of the question. It thus behooves the researcher and clinician to know when and how the Inventory is likely to give valid results and to use it only in those situations: there appear to be a number of these, as this discussion shows.

Having summarized in this general way the uses to which the Bernreuter has been found to lend itself, it seems desirable to end with a brief description of the empirical value of each of the scoring keys, to supplement the more theoretical discussion concerning the traits they measure.

SIGNIFICANCE OF BERNREUTER SCORES

B1-N. High scores on this scale tend to be made by emotionally unstable persons and by those who tend to withdraw from difficult social situations: neurotics, autistic schizophrenes, depressed individuals, hypothyroid cases, the hard-of-hearing, maladjusted normals, withdrawing individuals, the unhappily married, students seeking interviews on personal matters, cribbers, criminals, nurses, artists (?), persons agitated by frustration, and those who are unsuccessful in contact work. Low scores are made by emotionally stable persons and by those who are aggressive in difficult social situations: paranoid and manic individuals, hyperthyroid cases, leaders, fraternity men, students with good study habits, the happily married, oldest and youngest children, Negroes, Y.W.C.A. secretaries, physical education teachers, and persistent and punctual persons.

B2-S. High scores are made by self-sufficient individuals: neurotics (an exception), withdrawing persons, students who support themselves, leaders, those who are intellectually independent, undergraduate radicals, divorced women, youngest children, only children, Negroes, very superior students, persistent and punctual people, and persons in contact occupations. Low scores are made by dependent persons: epileptics, cribbers, fraternity men, nurses, and by persons working with records and materials.

B3-I. Resembles B1-N empirically as well as theoretically.

B4-D. High scores on this scale are made by persons who tend to dominate in face-to-face situations: employed persons, very superior students, leaders, fraternity men, divorced women, youngest children, those in contact occupations, those in the higher socioeconomic groups, Negroes, and Jews. Low scores tend to be made by those who are submissive: epileptics, hypacusics, withdrawing persons, newcomers in a society such as foreigners, the unemployed, nurses, and persons working with records and material objects.

F1-C and *F2-S.* These have not been used in enough studies for empirical data of the above varieties to be available. It has been shown in one study that they have much the same significance as the B scales, F1-C being like B1-N, and F2-S like B2-S.

To the theoretically inclined, the above summary may look like the height of empirical folly. Some will wonder at finding leaders classed with paranoid, cribbers with epileptics. A moment's

thought should explain these apparent oddities. A test score represents position on *one* continuum: for this reason unexpected groups will be found rubbing shoulders. To understand any particular group or individual we must, however, take into account more than one trait. When several traits are considered at once, as by St. Clair and Seegers (122), it will be found that leaders and paranoids are no longer bedfellows. At the same time, study of the material just presented will show that there is a substantial amount of logic and consistency in the groups sharing a given trait. It is psychologically as well as empirically sound, to cite just a few examples, to classify neurotics, schizophrenes, depressed and hypothyroid cases, withdrawing individuals, those seeking help in personal matters, and the unsuccessful in contact work as emotionally unstable.

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BOOK REVIEWS

BARTLEY, S. H. Vision: a study of its basis. (With an historical perspective by E. G. Boring.) New York: Van Nostrand, 1941. Pp. xv + 350.

In an illuminating historical introduction Professor Edwin G. Boring properly labels this book *a handbook on the psychophysiology of vision*. However, the book is more than a compendium of facts. It is concerned with some of the most important problems in the field of vision and provides a critical review and summary of many new experiments. The newness of the material is attested by the fact that 70% of the 241 end-of-chapter references deal with experimental studies in vision published since 1935; 97%, since 1926.

The author, an active worker in one of the world's foremost neurophysiological laboratories, has a broad background of training and experience in experimental psychology and neurophysiology and is one of the few persons uniquely qualified to write such a book. He dedicates his book to G.H.B. and R.H.W. For nearly a decade the author has been a research associate of the former, George H. Bishop, in his laboratory in the Washington University School of Medicine. To the latter, Raymond H. Wheeler, he no doubt owes his early interest and training in psychology. The influence of viewpoints of both men are discerned throughout the text.

As stated in his introductory preface, the author makes no pretense of surveying the entire field of vision. He has chosen instead to attempt to integrate certain phenomenological and experimental observations in the psychology of vision with some of the more recent neurophysiological data, many of which have been discovered only recently through the application of newly developed techniques in electrophysiology. Better aware of the contributions of electrophysiology to the understanding of the sensory mechanism of cutaneous and muscle receptors, or even in the more complex area of audition, the psychologist and physiologist will no doubt be surprised to learn that such a wealth of data of this kind has been quietly accumulated in the field of vision. Throughout, the author adeptly applies new or expanded neurophysiological concepts, along with anatomical and histological facts, to the better understanding of experiments in the psychology of vision. Again and again theories of vision and experimental results explained in terms of hypothetical peripheral mechanisms or substances are shown to have probable central nervous system coördinates. Occasionally one may get lost in a fine neurophysiological mist, but for the most part the explanations are basic and clear.

The plan of the book is well conceived and appears to follow a systematic ordering of topics. Beginning with visual functions and factors primarily dependent upon peripheral mechanisms of the eye and retina, the author leads to problems and methods bearing more heavily on central nervous system functions, closing with the characteristics of cortical responses recorded electrically. The introductory chapter discusses the nature of vision and outlines various methods of studying visual prob-

lems. A number of fundamental considerations in relation to visual experience are taken up in the second chapter. These pertain to various types of thresholds and the interrelations of area, intensity, and time in brightness discrimination, visual acuity, and binocular vision. Chapter III deals with methods of demonstrating the effects and mode of action of entoptic stray light. Its importance to the interpretation of various experimental studies in vision is frequently stressed throughout the book.

Chapter IV deals with the sense cells and the structure of the retina in relation to visual theory. Hecht's photochemical theory and the duality theory of vision are discussed and criticized. Experiments bearing on the anatomy and function of the blind spot are taken up in Chapter V. The importance of the time factor in visual experience is excellently portrayed in Chapter VI, which deals with flicker and fusion phenomena. The detailed results of a number of experiments on the perception of movement are presented in Chapter VII. The various types of perceived movement, both real and apparent, are discussed and explained. Chapter VIII provides a comprehensive treatment of the adaptation phenomena in vision. Theories of adaptation are critically reviewed.

Chapter IX is one of the most important sections of the book, for it gives a clear picture of the latest neurophysiological concepts of neural interaction, especially as applied to visual phenomena. This chapter clarifies many of the neurophysiological conceptions alluded to in earlier chapters and might profitably have been inserted nearer the beginning, although it does form continuity with those chapters on nervous action which follow. Chapter X presents a number of psychological phenomena involving contour, for which the author finds present concepts of neural interaction inadequate and looks to the future and some new theory based on field properties. Both in this chapter and the chapter on perception of movement the author espouses the vector-field analysis of Brown and Voth.

The experimental material and the methods described in Chapters XI, XII, and XIII have never appeared in book form before. The first of these gives a detailed description of the electroretinogram, its characteristics, and their relationship to retinal and sense-cell function in the eye. The next two chapters, the optic nerve discharge and the cortical response, bear almost entirely upon the work of Bartley and Bishop and their collaborators. These chapters form a partial summary of a large number of published studies in which some extraordinary techniques of analysis of neural function have been devised and striking results obtained. The kind of fact uncovered in these studies is basic and will certainly play a prominent part in the theories of vision of the future. Although mentioned in an earlier chapter on sense-cell action, one wonders why the work of Hartline, Graham, and Riggs was not referred to in connection with the optic nerve discharge. The final chapter summarizes accomplishments and calls attention to unsolved problems.

Despite the fact that the author has made a good attempt to simplify and condense a large amount of difficult and technical experimental material, students will not find this an easy text to read, nor for that matter will more experienced hands find the going smooth. However, the juice

that the meat contains is certainly very well worth the chewing. The text is liberally and extremely well illustrated; the format and printing are excellent.

DONALD B. LINDSLEY.

Brown University.

MILLER, N. E., & DOLLARD, J. Social learning and imitation. New Haven: Yale Univ. Press, 1941. Pp. xiv + 341.

Miller and Dollard present in this volume a combination of theoretical discussion and observational and experimental data on learning theory, imitation, and social behavior. The learning theory expounded in the beginning chapters is based on the work of Thorndike, Pavlov, Watson, and, chiefly, Hull. It is, the authors state, most briefly described as "a reinforcement theory of social learning." Emphasis is given to the roles played by drive, the cue stimulus, response, and reward. Learning is defined as occurring when a particular response comes to be elicited more regularly by a specific cue stimulus under conditions which motivate the subject and reward this stimulus-response behavior. The theoretical discussion is deceptively simple, but one should not be misled by that simplicity—considerable penetrating analysis of learning lies behind it.

The theoretical background developed in the first chapters is applied to the process of learning to imitate. The type of imitation discussed in greatest detail may be illustrated by one of their experiments with white rats. The rat serving as leader had previously been trained to approach a black card in a one-choice T-maze; the imitator was now to learn to follow the leader. The factors involved are represented by the authors in this paradigm:

	<i>Leader</i>	<i>Imitator</i>
Drive	Hunger	Hunger
Cue	Color of card	Leader running and turning
Response	Turning toward card	Following leader
Reward	Food	Food

The cue for the imitator is dependent upon, and his response is matched with, the response of the leader. Accordingly, this type of imitation is labeled "matched-dependent" behavior. Both naturalistic observations of child behavior and a number of ingenious experiments are used to illustrate the detailed working out of this pattern in a variety of situations. The experimental results with animals and children "confirm the deductions from learning principles by demonstrating that imitation of a given response will be learned if rewarded and that, when learned in one situation, it will generalize to new, somewhat similar situations." For example, rats trained to follow a white rat as leader followed a black leader with considerably better than chance accuracy. When the drive was changed from hunger to thirst, the imitative behavior was transferred almost perfectly. Finally, the habit was transferred, with slightly better than chance accuracy, to a new, four-choice situation. Rats trained in the

same way not to imitate the original leader showed a similar generalization of this habit.

The final chapters apply the principles of learning and the knowledge of imitation to the process of cultural borrowing, to social situations and crowd behavior in general, and to the behavior of a lynching mob in particular. These extensions are necessarily much less rigorous than the simpler learning experiments, but the more complex social situations may be analyzed and described in terms of the same components which were studied in greater detail in the simpler situations.

The book ends with two appendices, a bibliography, and an index. One appendix revises Holt's famous reflex-circle theory of imitation; the other comments briefly on a number of other theories of imitation and reviews the earlier experimental work on the problem.

The volume was written for the whole group of social scientists and not for psychologists alone. The style adopted for this audience is elementary, somewhat diffuse, and apologized for in advance by the authors. The psychologically-trained reader may wish that the book had been condensed to half its size, but he will be stimulated by the authors' analysis of learning to imitate, and he will find further proof of the power of a systematic theory to suggest new and important experiments. Since most of these experiments are yet to be tried out, *Social learning and imitation* may well serve for some time to come as a significant part of the orientation directing the work of others interested in imitation, social psychology, and group behavior.

DAEL WOLFLE.

University of Chicago.

MORGAN, J. J. B. *Psychology*. New York: Farrar & Rinehart, 1941. Pp. xxi + 612.

Among the many recent textbooks in general psychology, this one will hold a high rank for its scholarship, concern with basic concepts derived from experiments, and freedom from adherence to a psychological school of thought. Its chapter headings will have too familiar a ring, suggesting a return to older procedures to those who have stressed applications before fundamentals, but the contents of each chapter have the merit of being grounded in the most recent investigations within the field of psychology. Perhaps the emphasis on description of psychological processes as they relate to specific conditions of stimulation distinguishes this text, although there is not lacking a judicial consideration for the practical implications of psychology.

The seventeen chapters of the book deal with the following major topics: "The Scientific Attitude"; "Heredity and Environment"; "Prenatal and Infant Development"; "Intelligence"; "Springs of Action"; "Social Motives"; "Emotional Behavior"; "The Acquisition of Motor Skills"; "Conditioned Reaction Learning"; "Memorizing"; "The Central Nervous System"; "Vision"; "Hearing"; "Smell, Taste, and Somesthesia"; "Perceiving"; "Problem Solving"; and "The Psychological Individual." This last-named chapter in some texts would be called "Personality." Mor-

gan has, however, gone beyond the ordinary treatment of personality by interrelating in this chapter many of the concepts covered earlier in the book. Most of the chapters are richly illustrated, each sharing appropriately the 192 figures designed to aid the student in grasping methods and results in psychology. Statistical emphasis is slight, as attested by the inclusion of only seven tables.

Two additional features deserve notice. More than is usual, the questions for review suggest that the author has taken his task seriously and, perhaps, has been aided by using them in his teaching. A student who attempts seriously to answer the questions must review his assignment frequently, for the questions are specific rather than general. The second noteworthy and useful aid to the student is the 25-page glossary. This reviewer is pleased to find an instructor who recognizes the problems faced by beginning students as they seek to cement ideas by the use of appropriate, technical terms.

Perhaps some psychologists will wonder why Morgan, in returning to basic concepts, has followed the more recent trend of relegating chapters dealing with nervous integration and sensory processes toward the end of the book. Had he dealt primarily with generalizations and applications, the procedure might have been easier to rationalize. Other psychologists may consider the book too difficult for beginning students; Morgan, himself, seems to sense this. The reviewer believes that superior students must often suffer because of the incompetency or indifference of the "average" student and that they will welcome the confidence inspired by this book in psychology as a body of substantiated knowledge.

CHARLES BIRD.

University of Minnesota.

BOOKS AND MATERIALS RECEIVED

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HOLZINGER, K. J., & HARMAN, H. H. Factor analysis: a synthesis of factorial methods. Chicago: Univ. Chicago Press, 1941. Pp. xii+417.

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WECHSLER, D. The measurement of adult intelligence. (2nd ed.) Baltimore: Williams & Wilkins, 1941. Pp. xi+248.

WHITING, J. W. M. Becoming a Kwoma: teaching and learning in a New Guinea tribe. (With a Foreword by J. Dollard.) New Haven: Yale Univ. Press, 1941. Pp. xix+226.

NOTES AND NEWS

THE department of psychology of Vassar College announces the establishment of the MARGARET FLOY WASHBURN FUND, income from which will provide aid to graduate and undergraduate students of psychology at VASSAR COLLEGE. The Fund represents donations from students and friends of Professor Washburn, as well as the residue of her own estate. During the year 1942-1943 a graduate fellowship of \$1000 will be available.

A special "GRADUATE DIVISION OF CONSERVATION" has recently been organized at Vassar College, the purpose of which is "to qualify leaders in problems of community and mental well-being in a democracy." The department of psychology will participate in the work of this new Division. The degree of Master of Science will be awarded to graduate students who complete satisfactorily an approved program of studies and research.

Graduates of the Division will be eligible to apply for two generous fellowships, which would permit them to continue their work toward the doctorate in an appropriate university: (1) the Katharine Bement Davis Memorial Fellowship (\$2000), for two or more years of constructive research in problems of environmental influence on adolescent mental health; (2) the Myra Reynolds Memorial Fellowship (\$2000), for two or more years of constructive research in problems of mental health.

For further information, write to Lyle H. Lanier, Department of Psychology, Vassar College, Poughkeepsie, New York. Applications for the Washburn Fellowship should be sent by April 1, 1942.

THE EMERGENCY COMMITTEE IN PSYCHOLOGY OF THE NATIONAL RESEARCH COUNCIL hopes to keep an accurate record of the contributions made by psychologists to national defense. In order to keep this record, the Committee publishes this urgent request that every psychologist who is now engaged in, or who later enters into, work directly connected with the country's military effort should inform the National Research Council of his activities. (A detailed statement of duties, or of the nature and results of research programs, is not necessary at this time.) This request is made to psychologists serving in a civilian capacity as well as to those in the armed forces.

Communications should be sent to Mrs. Marion Hale Britten, Division of Anthropology and Psychology, National Research Council, 2101 Constitution Avenue, Washington, D. C.

THE SOCIAL SCIENCE RESEARCH COUNCIL has asked us to inform our readers that less than 300 copies of *The prediction of personal adjustment* (455 pp., \$2.00), by Paul Horst and others, remain in stock. The type is being held, but will have to be broken up by March 15. It is consequently asked that persons intending to order copies do so promptly so that a decision may be made as soon as possible about the printing of an additional supply. It is particularly desired that individuals intending to use this monograph in connection with graduate courses next fall notify the Council now, without any obligation to purchase, of the approximate number of copies which will be required.

